CHEMICAL & METALLURGICAL ENGINEERING

Chemical Show Exhibit

Our exhibit at the National Exposition of Chemical Industries, 1920, shown above, included meters for Steam, Water, Chemical Solutions, Gases and Vapors.

At the Chemical Show to be held in the 8th Coast Artillery Armory, New York, September 12-17, 1921, we will have working exhibits of the following

New Equipment

Specific Gravity Recorder, for Liquids and Solutions (Compensated for Temperature.)

Meters for Granular Material.

Meter and Feeder for Pulverized Coal and Powdered Material.

Recording Tachometer.

Ash Pit Loss Recorder showing percentage of combustible lost.

Draft Gages.

Differential Gas Pressure Recorder accurate to 1/10,000 inch of water.

Miniature Boiler in Service demonstrating operation of Bailey Boiler Meter recording Steam Flow and Air Flow.

The most attractive features of last year's exhibit, including water flowing through glass pipe, V-Notch Weir and Air Meters in Operation, will be repeated.

BAILEY METER COMPANY
2025 E. 46th Street, Cleveland, Ohio

For the Edification of Readers and Advertisers

MAY we have your indulgence while we talk shop for a moment? Contrary to the impression of an earlier day, the editorial conduct of a modern technical magazine is not a chance feature of the publishing business. On the contrary it is the result of a deliberate policy that forms, or should form, the foundation for the whole superstructure of service which is the magazine's *raison d'être*. Now a modern magazine serves three groups of people: the readers, the advertisers, and the publishers. All contribute to the success of the undertaking, and each must profit by what he puts into it or he will not continue to invest. The reader must have a sense of value received for the subscription price; the advertiser must feel assured of the buying power of the circulation; and the publisher must realize a fair return on his investment which is the recognized reward for his enterprise and risk. Let any one of these elements fail to realize a reasonable degree of satisfaction over an extended period of time, and the whole structure will fall to the ground.

Perhaps it is not overstating the case to say that not only will editorial competence assure the reader a reliable and useful professional tool, but that editorial integrity will also constitute a basic guarantee of the magazine's value to the advertiser. In other words, high standards of editorial ethics and practice will react to the benefit of not only the reader but of the advertiser as well, and ultimately of the publisher. It is of course assumed that equally high standards of business practice are recognized; but for the moment we are emphasizing the value of editorial integrity, because it is in that department that a surrender to low standards would work fundamental harm and perhaps ultimately ruin the publication through loss of confidence and prestige.

With this brief preamble we offer for the edification of our subscribers and advertisers the standards of editorial practice recently adopted by the Editorial Conference of the New York Business Papers, Inc., of which CHEMICAL & METALLURGICAL ENGINEERING is a member. Certainly they represent the best thinking of the day on the part of an important group of editors, each of whom has pledged himself

1. To consider first the interests of the subscriber.
2. To work for truth and honesty in all departments of his publication.
3. To publish in an impartial way, free from personal opinion, the news of the industry in which his paper circulates.
4. To disregard advertising considerations in the editorial conduct of his paper.
5. To be a leader of thought in his editorial columns and make his criticisms constructive, with the object of bringing his industry to higher levels of thought and practice and to a greater measure of public service.
6. To support in his columns such worthy measures of public interest as their importance justifies and the space available permits.
7. To give proper credit for articles taken from other publications, and to avoid unfair practices in competition with them.

It will be noted that the interest of the subscriber, the reader, is the editor's first consideration. This is quite logical, for if the editor cannot produce a magazine that readers will buy continuously and in large volume, it will have no value as an advertising medium and will yield no revenue to the publisher. The magazine is made primarily for the reader because if his interest and loyal support can be maintained he becomes a receptive and impressionable audience for the advertiser. Confidence thus gained editorially is automatically converted into a business asset.

Probably none of the other standards enumerated above requires elucidation unless it be No. 4. It is a difficult standard to phrase; but it is intended to express editorial independence of that baneful influence which was more characteristic of the early days of business publishing, but which is still sometimes exerted on the editorial department by advertisers. The purpose of that influence is variable. Sometimes it is merely to gain additional publicity through the text pages. Occasionally it takes the form of propaganda, more or less insidious and difficult to recognize. But its most pernicious manifestation is an attempt to influence editorial policy or to suppress publication of articles, using as a club the threat to withdraw advertising patronage.

Of course it is the sincerest recognition of the value of the text pages that advertisers should want "reading notices" and all that category of trade items published therein; but the editor is not justified in publishing them unless they interest or instruct the reader. Certainly it is a mistaken point of view to regard the publication of such items as an advertising perquisite. And as for allowing editorial policy or purpose to be swayed by pressure from an advertiser, second thought will make it very clear that such a course would lead to editorial and business practices of the most pernicious character, bordering on bribery and blackmail if not actually descending to them. The very thought is abhorrent and quite inconsistent with the fundamental truth of science and honesty of engineering. Editorial integrity should not only be expected but demanded by advertisers.

As a whole we regard the standards of the New York business paper editors with approval and satisfaction and subscribe to them with pleasure, feeling that they will aid in bringing the whole field of business and technical publishing "to higher levels of thought and practice and to a greater measure of public service." Publisher, advertiser and reader could ask no more; and in devoting his primary attention to the reader's interests the editor feels that he is contributing directly to the consummation of this desirable state of affairs.

Who Knows About Internal Strain?

A PAPER by JAMES E. HOWARD, reprinted on another page of this issue, brings to mind the need of investigations in a neglected field, but necessary before the mechanical engineer and designer can make the best and most economical use of the quality materials furnished by modern metallurgy. We refer to work immediately directed at the everyday problems of stresses and strains; questions which arise from the service requirements of steel and the best methods to meet them. Such things are most essential for intelligent and scientific design, and there ought to be a ready fund of information about them; but very little is available and less is being presented. Efforts of metallurgists are largely concentrated upon the production of uniform metal of superior physical properties; they leave it almost wholly to the user to determine the kind of service these steels shall enter, and doubtless in most cases they are unfamiliar with many matters pertaining to the actual problems which the uses of steels present. The user, on the other hand, rests secure in the thought that if a certain part shows a high percentage of failures, it can be "redesigned," or made of another metal selected from the almost bewildering number now available.

Engineers and scientists have really been progressing but slowly into the general problem of distribution of stress in a resisting solid. HOOKE enunciated his law that the "power of a spring is proportional to its stretching" in 1676, but an arithmetical figure for this proportion was not forthcoming until 1807 when YOUNG described the physical constant now know as Young's modulus. POISSON, twenty years later, established the ratio between lateral contraction and longitudinal extension. The problem of a shaft in torsion was not solved by SAINT VENANT until 1855, and about that same time the simplified beam formula $M = \dfrac{pI}{E}$ came into general currency. Since that time there has been little more than the production of a maze of figures, symbols and equations based on Hooke's and Poisson's laws, attempting to determine the stress distribution in rectangular beams without using several slightly erroneous but simplifying assumptions, and in flat or curved plates. When the beam becomes a column, or is a built beam, or the plate has a few holes or notches, either internal or external, then even this mass of figures, not understandable to any except expert mathematicians, becomes useless, and the engineer must rely upon his good friends Common Sense and Factor of Safety.

Prof. COKER has but recently taken a long step forward by constructing models of glass, celluloid or other transparent amorphous substances, and has been able to exhibit visibly the distribution of stress by the production of beautiful colored patterns due to double refraction of transmitted polarized light. He finds, for instance, that the distribution of stress at a contact surface is all important in that region. Its distribution, easily found by these models, is in such cases of much more importance than its exact magnitude, found laboriously, if at all, by complicated mathematics—for by proper experimentation methods may be devised to remove dangerous concentrations. Once removed by correct design, who cares how big they might have been?

Something has been done in studying the mechanism of failure. LÜDER (in 1859) noticed that plates or rods loaded slightly higher than the elastic limit developed geometric surface markings, indicating regions within which a shearing deformation had taken place. Experiments of this kind have been a very useful guide for workers in the theory of elasticity, and in indicating where dangerous stress intensities will develop in intricate shapes. Much more valuable information has been forthcoming in the last few years following the recognition of the fact that metals are crystalline aggregates, and by the microscopic study of deformation, normally caused by slip among cleavage planes in the crystal itself. This at least has given us a good idea of the way to harden and strengthen metal and just what happens when a metal is overstrained.

However, these studies are of conditions which exist at very high loads, loads which are much beyond those an engineer would like to impose on his structure. What he expects of the metallurgist is homogeneous metal, free from internal notches and invisible defects. The metallurgist must ever strive to approach this ideal. Nor can he remain entirely indifferent to questions which merit the designer's most careful attention: How much less is the resistance to shear on a plane which already bears a certain tension? How much tension will metal endure when it is prevented by sidewise constraint from contracting laterally? What is the relation between the stresses set up in a piece by a load at rest, or the same load dropped one foot? Do the same forces come into play in resisting indentation and cutting?

Studies of minute movements in the interior of opaque bodies are bound to be very difficult; but that is no reason why they should be dodged.

Patent Litigation of Unusual Interest

SELDOM has a case in the courts attracted the interest of the chemical industry in so great measure as has the litigation over the patents for synthetic phenolic resins. As a result of a second long-drawn-out legal contest, three more of the original patents of Dr. BAEKELAND have just been declared valid and infringed. In the case under trial the patents were those relating to the molding and application of the synthetic resinous material, while it will be recalled that in the previous suit the so-called varnish and solution patents were those in question. The present suit was brought against a user rather than the manufacturer of the synthetic gum, although, as pointed out in the Court's opinion, the trial largely hinged on a consideration of the nature of the synthetic product itself. Naturally the manufacturer of the infringed product was deeply interested in the success or failure of his customer's case and stood squarely behind the defendant in all discussion relating to questions of patentability.

Judge CHATFIELD'S opinion is an exact and comprehensive survey, which is of historical importance both from the technological and purely legal viewpoints. Elsewhere in this issue a few pertinent paragraphs have been abstracted from the opinion, but the character of the document is such as to warrant a much more extended study by all who are interested in the scientific and commercial aspects of this important chemical industry.

We have previously referred to the contest as one of

long duration and perhaps we have been too critical of the processes of law and justice. Many cases, especially under the older régime of patent litigation, have extended over periods of many years, so that in this particular instance action may not have been unusually slow. The complaint was filed Sept. 18, 1917, but it was not until March 31, 1919, that the case could be brought to trial. The taking of testimony extended over many weeks and the final arguments were heard on June 22, 1919. Two years then elapsed, during which the presiding judge prepared his opinion and rendered his decision. To some this may seem excessive and sufficient even to call for the use of a catalyst or organic accelerator. When one considers, however, the great mass of testimony involved and its technical and scientific nature, it is evident that much careful, time-consuming study is required.

Turning our attention again to the Court's opinion, we are immediately struck with an interesting and logical comparison. Judge CHATFIELD declares that "if artificial diamonds could be produced, no one could claim as invention the substance already known as diamonds, and if the imitation could not be told from the original, no inventor could control all the material of that nature, whether produced naturally or artificially. But the inventor who does finally invent a process for manufacturing genuine diamonds, by artificial means, will be able to claim as an inventive product that material which any one is producing by the steps covered by his invention, if he obtains a patent therefor.

"Thus in all the BAEKELAND patents, the product which is sought to be patented is not the material, which can only be identified as an infusible and insoluble condensation product of phenol and formaldehyde. But BAEKELAND can validly claim a new product, which is produced by exactly the steps which he has described and which makes use of the ideas which he recognized and claimed as invention in arriving at a result which may then contain or even be substantially composed of a substance that of itself is not patentable, provided it can be shown that it was manufactured in a way not taught by the prior art, and can be identified by the original methods or steps in the process."

Newspaper Electrochemistry

IT DOES beat all what we read in the newspapers! Here is a gem of wisdom sent in by our electrochemical friend who led us into temptation that landed us in trouble about rhodium when we failed to observe that there is also a plant of that name. The item is taken from the New York *Sun* of Aug. 9, and was printed under the caption Kitchen Economics: "If a needle is held between the lips while peeling onions, water will be kept from the eyes, and it also prevents smarting." What kind of galvanic action does it set up? Was it meant for girls with metallic lips? We have always felt that there was a considerable electric charge in some lip tissue, but we have never undertaken research with cooks or scullery maids. On the other hand, one doesn't have to be a cook or a scullion to peel onions. We have done it ourselves, but in all our long, modest life we have not been given to understand that our lips were especially charged with electrons. Chemists working with mercaptans might make a note of this alleged phenomenon of the needle—and then they might as well forget it again for all the good it is likely to do them.

The Ups and Downs of Steel

JULY, 1921, will probably go down in history as the month of lowest production of steel in these modern times. Production of ingots in July was at the rate of about 11,000,000 gross tons a year, or about 21 per cent of actual capacity, the lowest rate being struck at the middle of the month, since when there has been an improvement, one that will probably continue indefinitely, though perhaps at a slow rate. The July rate was approximately one-fourth the average rate maintained during the first nine months of 1920. Approximately the same rate was struck for a short time after the panic of October, 1907, but for production in a year as little as 11,000,000 tons one must go back to 1900. Production in the best year before the war was almost three times as great.

In contrast with this very low rate in steel production there is the fact that the railroads have been and are hauling a little more freight, measured by ton-miles, than in their best year before the war, that having been the fiscal year ended June 30, 1913, when the revenue ton-miles were 301 billion.

One is reminded that old descriptions of the steel industry are more apposite than ever. The late ANDREW CARNEGIE coined the phrase "prince or pauper" industry. The late JAMES M. SWANK had previously referred to "chill or fever" and "feast or famine." That is, the producers of steel are either princes or paupers, buyers have either a fever or a chill, orders for steel suggest either a feast or a famine.

Being in large measure a construction material, steel exhibits variations in demand according to the volume of construction. Men eat bread and wear clothes every day, but only occasionally build a house, a factory or a power plant. Other factors, however, magnify the peaks and troughs in the demand upon the steel mills. Between the steel mills and the ultimate consumption there is a volume of material, including rolled steel products and various wares made from steel, in the hands of manufacturing consumers, wholesalers and retailers. When business is active this is a stream, but when business becomes bad the stream becomes a reservoir, which has to empty itself. Manufacturing consumers whose policy had been to keep a three or six weeks' supply of steel on hand liquidate their stocks, intending for a time to depend on carload shipments.

During the war there were fears that the steel industry was getting oversized for a normal peace-time consumption. Such fears may have been right or they may have been wrong, but that has nothing to do with the present condition, for the reason that the increase in capacity since 1914 has been about 50 per cent, so that a 20 per cent operation of today's capacity means the same tonnage as would have required 30 per cent of the capacity before the war.

Meanwhile the wear and tear of the machinery, implements and structures made of steel goes on, and men's vision grows as to the bridges, buildings, power plants and other things they will be able to employ usefully in future. Eventually the steel trade will "come back." Just now, as the reservoir between mill and ultimate consumption is being depleted of steel and manufactures of steel, the mill demand is working its way up to a normal relation to general business. Stocks of steel and of manufactures of steel have been in process of liquidation.

Readers' Views and Comments

The Microscope; Its Design, Construction and Applications

To the Editor of Chemical & Metallurgical Engineering

SIR:—Under "Book Reviews" in your issue of June 29, 1921, I find a review of the very excellent symposium on "The Microscope; Its Design, Construction and Applications" held during 1920 by the Faraday Society.

I find that Dr. Boylston, in quoting the summary of an investigation by Prof. Benedicks of the new Reichert metallographic outfit, which was largely designed by me, leaves out an important sentence reading as follows: "It was found to produce excellent results at the very highest magnifications." Benedicks considers this sentence as the main result of his investigation and mentions the other points cited by Boylston simply as "points of a more general character," since six out of the seven points mentioned do not refer to the apparatus under investigation, but to the subject in general.

Prof. Benedicks has published several other papers on the same apparatus, in which he goes more into details of the results of his investigations than he did in his short paper contributed to the Faraday Society symposium.

The success of this excellent symposium is undoubtedly due to the untiring efforts of Sir Robert Hadfield, and I was glad to accept his invitation to contribute a short paper to the same symposium.

New York City.   HERMAN A. HOLZ.

Note on Alloying Tellurium With Some White Metals

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the paper on the above subject by J. H. Ransom and C. O. Thieme on page 102 of the July 20 issue of your journal, there should be little difficulty in proving that tellurides of the white metals are formed instead of leaving the matter in the "probable" class, as is done in the authors' last paragraph. Indeed, I have no doubt that the authors actually did obtain tellurides, since in my own work on this subject more than fifteen years ago I invariably obtained them. This could be proved by the fact that the lumps which formed over the metal gave hydrogen telluride when treated with a weak acid.

The "glow" which the authors noted as taking place when the tellurium was immersed in the alloys and metals which they were using was due to the chemical action resulting in the formation of a telluride. Telluride of aluminum is a particularly interesting body, because it not only gives hydrogen telluride when treated with weak acids but even when treated with water only, making it the most convenient reagent that I know of for generating this gas. Aluminum telluride is itself easily made by melting aluminum in a scorifier or porcelain crucible and dropping tellurium into it.

Magnesium telluride is also an interesting compound and is made the same way, but care should be taken not to superheat the magnesium above its melting point or an explosion takes place and the magnesium telluride is found mainly on the walls and roof of the muffle. I always preferred to wear a mask and heavy goggles when making magnesium telluride, for the reaction is violent and comes in the hazardous class.

The selenides may be prepared in the same manner. It should perhaps be recalled to mind here that anyone experimenting on producing hydrogen selenide or hydrogen telluride should be most careful about inhaling either of the gases. To most persons they seem far more poisonous than sulphuretted hydrogen. As to hydrogen selenide, may I recall the classic quotation that "its discoverer, Berzelius, had his olfactory nerves paralyzed for six months by inhaling a bubble of the pure gas"? Judging from my own experiences, in the one whiff that he must have caught before paralysis set in he had enough olfactory sensations to have lasted him longer than the six months specified.

New York City.   DONALD M. LIDDELL.

Determining Factors for the Life of a Pneumatic Tire

To the Editor of Chemical & Metallurgical Engineering

SIR:—I trust it is permissible to call attention to a few corrections that should be made in the article on pneumatic tires, page 153. The subject matter is more mechanical than chemical, but as long as it was seen fit to publish this text, it is only proper that certain misleading ideas should be corrected in order that the readers of CHEM. & MET. should get complete facts on this great industry.

First, there are three types of pnuematic tires—square-woven fabric, thread fabric (so-called cord) and rope cord.

Second, use of cord fabric reduces the internal friction and heat developed in woven fabric tires, but it does not minimize these faults. The rope cord tire is built so there is a layer of gum rubber surrounding each of the ropes of the carcass. There is no rubbing between ropes and therefore this class of tire will not develop as much heat under the most severe road conditions as either of the two other types. In short, the rope cord tire practically reaches the ideal condition mentioned in the article.

Third, the rope cord tire is being manufactured at about 30 to 50 per cent less cost than cord fabric tires of similar size. The rope cord tire surpasses the fabric and ordinary "cord" tire in resiliency, absence of internal heat, gasoline mileage, bursting strength and cost of manufacture. The time is not far distant when the woven fabric tire and the cord fabric tire will both find themselves supplanted by the rope cord tire.

Fourth, a breaker strip functions to distribute the pressure occasioned by running over a stone or other angular projection so that the carcass of the tire will not receive a blow concentrated on a small area.

Fifth, iron cores are not used in building rope cord tires. The process is simple and eliminates much of the trouble from overflow, wrinkling of plies and breakers, bead weakness and other mechanical difficulties.

Arlington, N. J.   O. W. PICKERING.

British Chemical Industry

FROM OUR LONDON CORRESPONDENT

LONDON, July 21, 1921.

IT was long considered axiomatic that Manchester was the ultimate pulse for trade movements and at the present moment the distinctly improved tone and increased volume of business and employment in the cotton trade are considered to foreshadow a steady revival in the chemical industry and in the trade of the country. Important orders from America and India have contributed to this, but the absence of cheap coal is still a great handicap, as Belgian and German competition are likely to keep the majority of blast furnaces out of action for some time. Coal also remains the obstacle to a revival in the glass, pottery and similar trades, but the outlook in the chemical and dyestuff industries generally is better than for some time past, and although the immediate demand is small, it is known that stocks are now very low in most cases.

DELEGATES TO SOCIETY OF CHEMICAL INDUSTRY'S AMERICAN MEETING

Excluding the ladies of the party, the total number of members who have so far reserved passages is twenty or twenty-five. Sir William Pope, the president; Dr. J. P. Longstaff, the secretary, and E. V. Evans, honorary treasurer and chief chemist of the South Metropolitan Gas Co., are the official members of the party, which also includes the following, among others:

E. A. Alliott, of Manlove, Alliott & Co., filter press and mechanical plant specialists; F. W. Atack, well known in the dye industry, editor of the "Chemists' Year Book" and a leader in the movement toward compilation of compendia in English similar to Beilstein, etc.; R. H. Clayton, of the Manchester Oxide Co.; F. W. Gamble, of Allen & Hanbury, Ltd., manufacturer of pharmaceutical products; C. S. Garland, a vice-president of the society and chairman of Lighting Trades, Ltd., a subsidiary company to Nobel Industries; Captain C. J. Goodwin, honorary treasurer of the Chemical Industry Club, London, and the official delegate of the chemical engineering group of the society, a partner in Oscar Guttmann & Sons, consulting chemical engineers; W. Heap, L. A. Jordan, chemical engineer to the British Xylonite Co., Ltd.; J. MacWilliam, consulting metallurgist, Sheffield; J. Reid, of the Caldercruix Paper Mills, Airdrie, Scotland.

So far no visitors are announced from France, but it is always possible that there may be a last-minute rush from this country and in some cases, such as for instance, Emile Mond, business engagements prevent members from participating in the full programme and they may sail at a later date. P. le Good, the advertising manager, is also of the party and it is understood that a stall at the Exposition of Chemical Industries has been reserved by the society, at which full information regarding its publications and other activities will be available.

PARLIAMENTARY AND INDUSTRIAL NOTES

The committee stage of the key industries bill was something of a farce and perhaps it was just as well that the "guillotine" prevented further futile discussion. The bill is to come into operation on Sept. 30 and as regards "dumping" will not apply to any British dominion. As regards depreciated exchanges it will not now apply to cases where the currency concerned is less than 33⅓ per cent below the sterling par value.

Very encouraging reports have been received unofficially regarding the progress of the Claude process of nitrogen fixation and the various groups of experts who have seen demonstrations consider it to be commercially far superior to the Haber process. Considerable improvements have been effected in the process as disclosed by the patents so far published, particularly as regards the Claude method of hydrogen manufacture and the type of solvent used for same. Catalysis is said to proceed smoothly even in the presence of relatively considerable quantities of carbon monoxide.

In this connection, the discovery by the Catalpo interests (British Patent 164,808) that colloidal clay will synthesize ammonia at 450 deg. C. and at atmospheric pressure is of peculiar interest. Water vapor, it is stated, can be used instead of hydrogen and the use of this new catalyst is also advocated for hydrogenations and for the manufacture of acetaldehyde and formaldehyde.

LEADING CHEMICAL CORPORATIONS PASS DIVIDENDS

One result of the recent depression in trade, industrial unrest and Continental competition has been the passing of dividends in the case of firms like Nobel Industries and the British Dyestuffs Corporation. In the case of Nobel Industries considerable courage must have been displayed by the directors, for in spite of the fact that the profits for the past year were on a par with those earned in the previous two years, it was considered wise to keep all cash resources liquid. In such cases the directors themselves are usually holders of large blocks of shares and are therefore hit more heavily than the other shareholders and it is felt that foresight and caution of this kind will meet with its due reward later on. The case of the British Dyestuffs Corporation looks rather more serious, as it is the interim dividend on the preference shares that has been passed, but recent events and the changes in the management referred to in my previous letters have probably contributed to the present difficult position. As was generally expected, the report of the profiteering committee exonerated the dyestuffs industry but at the same time recommended caution and watchfulness in the future.

GENERAL NOTES

The annual meeting of the Association of British Chemical Manufacturers was a spectacular success, but doubt is expressed as to whether the actual work done apart from organization really corresponds to the claims made. This applies equally to the newly formed Association of Chemical Plant Manufacturers and considerable time will probably elapse before the notorious inertia of the British chemical industry can be finally overcome and really useful results attained. The annual report of the Alkali Works Inspectors follows traditional lines and its contents confirm the above opinion to some extent. Molybdenum metal is attracting interest at the moment and very large contracts could be placed provided supplies were obtainable at well under $200 per ton.

Action of Lime in Magnesium Oxychloride Cements

Detailed Study and Discussion of the Action of Lime Impurities Occurring in Magnesite on Magnesium Oxychloride Cements—Methods of Determining and Differentiating Active From Inert Lime

By MAX Y. SEATON, CLAUDE R. HILL AND L. C. STEWART

PLASTIC calcined magnesite differs from dead-burned or metallurgical magnesite in being burned at a much lower temperature. Dead-burned magnesite, in which periclase formation has gone on to a greater or less extent, does not react with magnesium chloride. The material now in use by the oxychloride industries is prepared by calcining any reasonably pure natural magnesite, such as occurs in Greece, in Venezuela, in Washington and in California, to a temperature of 700 to 1,100 deg. C. in shaft, Scott or rotary kilns. The commercial product is a white or light-colored powder, containing ordinarily 75-85 per cent MgO, 5-10 per cent CO_2 and H_2O, 1-2 per cent R_2O_3, 5-7 per cent SiO_2 and 3-6 per cent CaO.

The testing of plastic calcined magnesite has long been a serious problem to users of this material. An attempt has been made to regulate quality by specifying a definite chemical analysis which the material must meet to be accepted. Unfortunately, it has been found that poor as well as good calcined magnesite will meet these chemical specifications. The industry in general is coming to believe that a specification for this product should be written on the basis of physical tests only, with entire elimination of chemical analysis. The physical tests ordinarily recommended are those for fineness of the calcined magnesite, and for strength, constancy of volume, setting time, and resistance to water of the finished cement. Tests of this nature unquestionably furnish valuable information as to the quality in calcined magnesite. It is interesting to compare such test results with the results of chemical analysis and particularly to search for special analytical determinations which might throw light on the question of quality before totally abandoning the use of chemical tests. One determination which is frequently stated as being of particular value is that of the amount of lime in the calcined magnesite, and some investigation of the meaning of this determination seems warranted.

INERT AND ACTIVE LIME

From the start some distinction as to the form in which the lime occurs must be made. In many oxychloride cement mixes marble dust or limestone powder is deliberately used as an aggregate without exerting any harmful influence on the properties of the cement. Such forms of calcium carbonate act merely as inert material, their effect on the character of the cement being roughly equivalent to that of a fine sand or ground silica of equal fineness. The report of the presence of a definite amount of lime in a calcined magnesite is accordingly meaningless unless the form in which it occurs be also specified. It is well established that addition of calcium oxide or hydroxide to an oxychloride mix markedly diminishes its strength. Lime in this form or, more exactly, any form of lime which exerts an injurious effect on the quality of an oxychloride can

well be designated as "active lime," and it would be expected that a determination of the content of lime of this character would be of considerable value.

The reduction in strength caused by addition of lime to oxychloride cements has been mentioned by several writers. Quantitative data are quoted by Rourke.[1] A tabulation of his results is given in Table I, where the effect of lime addition on the cement formed from two different magnesites is shown.

A similar set of determinations in which strengths at both seven days and thirty days were investigated is shown in Table II. The very marked decrease in strength should be carefully noted.

TABLE I. EFFECT OF LIME CONTENT, AS DETERMINED BY ADDITION OF LIME

No. Lime Added	Tensile Strength, Lb. per Sq.In.			
	3.70%	2.69%	1.68%	0.67%
1	329	364	486	826
2	328	320	470	653

TABLE II. EFFECT OF ADDITION OF Ca(OH)₂ TO CALCINED MAGNESITE

1 part magnesite, 2 silex, 5 sand, by weight. 22 deg. Bé. $MgCl_2$

Per Cent Ca(OH)₂	Tensile Strength, Lb. per Sq.In.	
	7 Days	30 Days
0	490	882
1	397	562
3	347	473
6	150	247
10	207	230

Several different possibilities for the determination of active lime may be considered. One such method is indicated by the work of Duschak.[2] This method rests on the difference in solubility between calcium and magnesium hydrates in water. Duschak points out that if a sample of calcined magnesite be agitated with water for some time, the alkalinity of the water will correspond to the content of calcium oxide present in the original sample. The procedure which he finally adopted was the leaching of the sample with water by standing over night, followed by filtration and by titration with standard acid, using phenolphthalein indicator, the next morning. If the magnesite was burned at a temperature exceeding 1,000 deg. C., the lime was slowly and incompletely dissolved, but magnesites burned at lower temperatures gave good results. The method is simple and rapid as far as working time is concerned. It has been carefully investigated and the effect of various modifications in the procedure studied. In the series of experiments following, 2 g. of the calcined magnesite under investigation was added to 300 c.c. of CO_2-free water and agitated on a shaking machine for various periods of time and under varying conditions.

The rate at which lime is extracted is of course of importance. Table III gives some data on this subject.

[1] University of Wisconsin Bulletin 879.
[2] CHEM. & MET. ENG., vol. 23, p. 628.

It should be noted that when continuous agitation is employed a time very much shorter than that used by Duschak is apparently sufficient to completely remove the lime. Longer agitation, in fact, appears to reduce slightly the alkalinity of the solution. The effect of temperature on the determinations is indicated from the comparative determinations at four hours' agitation. This factor exerts apparently only a minor effect on the amount of free lime found.

TABLE III. EFFECT OF TIME OF AGITATION ON PER CENT CaO IN WATER SOLUTION

Magnesite No. 12. Temperature 18 deg. C.

Time	Per Cent CaO From Alkalinity	
	Phenolphthalein	Methyl Orange
0.25 hr.	1.49	1.57
0.50 hr.	1.47	1.55
1.0 hr.	1.43	1.48
2.0 hr.	1.49	1.55
4.0 hr.	1.53	1.63 (20° C.)
	1.41	1.52 (87° C.)
	1.30	1.40 (3° C.)
8.0 hr.	1.34	1.47
16.0 hr.	1.25	1.39
24.0 hr.	1.11	1.24
2 days	1.30	1.40
4 days	1.21	1.36
8 days	1.26	1.42
15 days	1.47	1.54

The reduction in alkalinity on long agitation can possibly be accounted for by action of the calcium hydrate solution on the glass of the bottles. That such an effect does exist is shown in Table IV, where the titrations of dilute calcium hydroxide solutions after varying periods of shaking are given. This effect, too, is seen not to be a major one, but is of about the order of the reduction in alkalinity shown in the previous table.

TABLE IV. EFFECT OF GLASS BOTTLE ON ALKALINITY OF Ca(OH)₂ SOLUTION

Time Shaken, Hours	Titrated to Phenolphthalein End Point C.c. N/10 Acid	
	Without Filtration	After Filtering
0	5.04	5.04
4	4.90	4.62
8	4.88	4.66
24	4.88	4.66
48	4.82	4.68

Maximum difference is equivalent to 0.18 per cent CaO, figured on basis of usual determination.

Question may be raised as to the meaning of the alkalinity titration—that is, as to whether all of the alkalinity is due to lime. Duschak has given some data on this point. Additional figures are given in Table V, in which a comparison of the amount of calcium oxide

TABLE V. DETERMINATIONS OF ACTIVE LIME BY MODIFICATIONS OF WATER METHOD

Magnesite	Per Cent CaO by Alkalinity of H₂O		PerCent CaO by Precipitation as Oxalate	Per Cent CaO by Alkalinity of 5 per Cent NaCl	
	Phth.	M.O.		Phth.	M.O.
1	0.34	0.45	0.23	0.95	1.53
2	0.37	0.43	0.38	0.83	1.15
3	0.29	0.39	0.27	1.19	1.61
4	0.43	0.50	0.44	0.92	1.20
5	0.72	0.80	0.76	1.04	1.23
6	0.72	0.78	0.71	1.17	1.26
7	1.03	1.07	1.14	1.26	1.40
8	1.34	1.43	1.47	1.70	1.85

as determined by titration of the alkalinity of the solution and calcium oxide determined by precipitation of the lime as oxalate is given. It is seen at once that the alkalinity may be taken as a measure of the calcium content of the solution. In this same table the effect of addition of sodium chloride to the water is shown. The results in this case are very much higher than when no sodium chloride is used. In particular the quite wide difference between the methyl orange and

the phenolphthalein titrations on the sodium chloride solutions from certain magnesites should be observed. It is probable that this is due to the increased solubility of calcium carbonate in the presence of sodium chloride.

ACTION ON MAGNESIUM CHLORIDE SOLUTION

There seems little doubt that the method described above will indicate the amount of calcium oxide or of calcium hydroxide actually present. Such lime, which may be designated as "free lime," does not necessarily comprise the total of the so-called active lime in the calcined magnesite. For example, the phenomenon of a striking reduction in strength of oxychloride cements on addition of small quantities of precipitated calcium carbonate has been frequently observed. Such calcium carbonate will show essentially zero alkalinity when agitated with water, yet its effect on the strength of oxychloride cements is almost as great as that of calcium hydroxide itself. It is felt, too, that an analytical method which approaches somewhat more closely to the conditions existing during the formation of the magnesium oxychlorides would be less open to criticism than the method given above. The solution used in mixing oxychloride cement is not water, but is a solution of magnesium chloride. Calcium oxide or hydroxide will of course react with such a solution with the precipitation of magnesium hydroxide and the introduction of calcium chloride into the reaction mixture. The literature indicates that certain forms of calcium carbonate will react in much the same way.

Some study of an analytical method in which leaching with magnesium chloride solutions is employed was accordingly undertaken. The method finally adopted was the agitation of 2.5 g. of calcined magnesite with 300 c.c. of 0.75 per cent magnesium chloride solution. After a specified period of agitation, the solution is made up to 500 c.c., filtered, and an aliquot part, usually 100 c.c., taken for analysis. Calcium is determined in the solution by double precipitation as oxalate, using the precautions which are always necessary when calcium is to be determined in the presence of a large quantity of magnesium. Use of such a method divides

TABLE VI. ACTIVE, RESIDUAL AND TOTAL LIME IN CALCINED MAGNESITE

Magnesite No.	Active CaO MgCl₂ Method	CaO in Residue	Sum	Total CaO on Separate Sample
K	1.53	2.82	4.35	4.34
L	2.82	0.81	3.63	3.89

the total lime present in the magnesite into two portions, as shown by Table VI. This table indicates the lack of relationship between total calcium oxide and active calcium oxide and indicates, too, the possible accuracy of the analytical determination involved.

The rate at which the active calcium present reacts with the magnesium chloride must be studied before the time of agitation can be definitely set. Some data on this subject are given in Table VII which shows that twenty-four hours' agitation is sufficient to remove by far the majority of the lime which will react, although some small reaction occurs even after this period.

On the basis of the data so far submitted, three methods for determination of active lime may be considered.

Agitation with water and determination of alkalinity with phenolphthalein indicator.

Agitation with 5 per cent sodium chloride solution and determination of alkalinity with methyl orange indicator.

TABLE VII. EFFECT OF TIME OF SHAKING ON PER CENT
CaO BY MgCl₂ METHOD

Magnesite No. 13

Time	Per Cent CaO	Time	Per Cent CaO
2 hr	2.80	2 days	3.49
4 hr	3.02	4 days	3.54
8 hr	3.19	8 days	3.93
16 hr	3.47	15 days	3.67
24 hr	3.45		

Agitation with magnesium chloride solution and determination of calcium chloride in the solution.

Comparison of the results obtained from the application of these three methods is given in Table VIII.

TABLE VIII. COMPARISON OF METHODS FOR ACTIVE CaO

MgO No.	Alk. in H₂O Phth. Ind. Method 1.	Alk. in 5% NaCl M.O. Ind. Method 2.	MgCl₂ Method Method 3.	Ratio 3:1	Ratio 3:2
1	0.34	1.53	1.54	4.53	1.02
2	0.37	1.15	2.00	5.41	1.74
3	0.29	1.61	1.59	5.48	0.99
4	0.43	1.20	1.88	4.37	1.57
5	0.72	1.23	2.30	3.19	1.87
6	0.72	1.26	3.35	4.65	2.66
7	1.03	1.40	3.28	3.18	2.34
8	1.34	1.85	4.00	2.95	2.16

It is seen at once that there is apparently no relation between the values thus obtained on the eight different calcined magnesites investigated. The ratio between the values is far from constant. Methods 2 and 3 are closer than methods 1 and 3, but even here the variation in ratio is very great.

DETERMINATION OF CALCIUM CHLORIDE PRODUCED IN CEMENT

The real test of the value of any such methods is, of course, their comparison with conditions existing during formation of the oxychloride cement. As has been indicated, a method involving treatment with magnesium chloride would be expected to be closer to practice than one employing leaching by water only. For a further study small amounts of oxychloride cement were prepared from three different calcined magnesites, using the strength and amount of magnesium chloride solutions ordinarily used in practice. These cements were allowed to set for varying periods. They were then powdered and agitated for a considerable time with neutral alcohol. It would be expected that this procedure would remove the majority of the calcium chloride formed by reaction of the active lime with magnesium chloride, although there is, of course, a possibility of the formation of small quantities of calcium oxychloride which might not be decomposed under such conditions. The alcoholic solution was then filtered and calcium determined in it, the results being calculated back to the basis of the original sample of calcined magnesite.

Results are given in Table IX. They indicate that the amount of lime reacting in such oxychloride cement mixtures is about midway between the amounts found by the water and by the magnesium chloride method. That they are considerably higher than the results found by leaching with water is, of course, good evidence that lime in other forms than that of calcium oxide or hydroxide does react in such cements in the ordinary mixes used in the field.

The results so far obtained have not entirely conformed to those reported by Duschak, who believes that all of the lime which will influence oxychloride cement formation can be leached out of a freshly burned sample of magnesite by water. It is suspected that the discrepancies in the results of the two laboratories may be

traced to the fact that the magnesites investigated here are commercial calcined magnesites which have, of course, been exposed to the air for varying periods during their shipment from the California producers, instead of being freshly burned samples such as were examined at Berkeley. Comparison was accordingly made between different methods as applied to freshly burned magnesite and to magnesites which had been exposed to the air for varying periods.

A sample of natural magnesite rock was burned for two hours at 750 deg., a burning condition which with this particular rock gave a good quality plastic calcined magnesite. Determinations of active lime were then made by three methods on this freshly burned product as well as on samples of it which were exposed on watch glasses to laboratory air for various periods of time. The results are shown in Table X. They are particularly interesting in indicating that the three methods correspond much more closely on freshly burned magnesite than they do on a material which has been weathered for a moderate period. This is further evidence that calcium carbonate may in certain instances behave as active lime and is a good argument for the adoption

TABLE IX. REACTION OF LIME IN OXYCHLORIDE CEMENTS
COMPARED TO ACTIVE LIME ANALYSES

Magnesite No.	Age of Cement, Hr.	Per Cent Lime Reacting in Cement	— Active Lime — H₂O	MgCl₂
2	24	0.92	0.37	1.54
2	60	0.92	0.37	1.54
8	24	2.33	1.34	4.00
8	60	2.48	1.34	4.00
9	24	2.33	1.24	3.97
9	60	2.33	1.24	3.97

of the magnesium chloride rather than the water method for a determination of this constituent in commercial calcined magnesite.

TABLE X. EFFECT OF WEATHERING OF CALCINED
MAGNESITES ON ACTIVE LIME CONTENT

Time Exposed to Air	Ignition Loss	Active Lime Method 1	Method 2	Method 3	Ratio 3:1	Ratio 3:2
0	1.09	3.14	4.18	4.69	1.49	1.12
1	3.62	2.52	2.94	4.17	1.65	1.42
2	4.00	2.46	3.09	3.90	1.58	1.26
5	5.73	1.05	1.58	3.07	2.92	1.94
10	5.86	0.72	1.62	3.26	4.53	2.01
20	6.97	0.59	1.36	2.45	4.15	1.80

CHLORIDE SOLUTION METHOD PREFERABLE

For use on routine samples of commercial calcined magnesites, then, it is felt that in spite of its obvious advantages in speed and in ease of manipulation, determination of alkalinity of extract is not as truly representative of the content of active lime as is the value arrived at by application of the magnesium chloride method. It is very probable that on freshly burned material, particularly on calcined magnesites burned at such a temperature as to completely remove the carbon dioxide from the lime, the water method will give results of approximately the same value as those found by the other procedure. This circumstance may make the water method of value to a producer, but cannot give it first place for use by a magnesite consumer, located a considerable distance from the calcining plant.

An additional argument for use of the magnesium chloride method for active lime is found in the fact that a definite relationship between certain physical properties of oxychloride cements and active lime content of the calcined magnesites employed, as determined by the magnesium chloride method, has been found to exist. In view of the lack of parallelism of results obtained by

the three methods, such a relationship obviously would not apply if free lime, determined by leaching with water or sodium chloride solution, were considered.

It is unnecessary to go into detail at this time on the methods used for physical testing of oxychloride cements and on the meanings of the various determinations as they have recently been published in this journal.[3] It need only be pointed out that a determination of the water resistance of oxychloride cements as defined by the relation between strengths of the dry cement and strength after wetting is of great interest as pointing to the comparative permanence of different products. A test of this type is conveniently made by determining the modulus of rupture of flat bars of the oxychloride cement $\frac{1}{2}$ in. thick under three conditions— namely, dry, immediately after wetting for a definite period, and after wetting and redrying for a definite time. The standard procedure in making water-resistance tests in this laboratory involves preparation and aging of the bars for fourteen days, spraying some of the bars for three 24-hr. periods with intervening 24-hr. drying periods and determination of the strength immediately after final spraying and after forty-eight hours additional drying in comparison with the strength of unsprayed bars. Water resistance is expressed both as the percentage of strength retained after wetting and after wetting and drying and as the "classification factor" of the magnesite, this being a numerical expression involving wet, dry and recovered strengths, the wet strength appearing as the second power on account of its relatively great importance. The formula employed for its calculation is

$$\frac{(Wet\ strength)^2 \times recovered\ strength \times 10}{(Dry\ strength)^2}$$

The derivation of this expression may be clearer if it be considered in the form

$$\frac{\left(\begin{array}{c}Wet\ strength\ as\ per\ cent\\ of\ dry\ strength\end{array}\right)^2 \times \left(\begin{array}{c}recovered\ strength\ as\\ per\ cent\ of\ dry\ strength\end{array}\right) \times \left(\begin{array}{c}dry\ strength\\ in\ lb.\ per\ sq.in.\end{array}\right)}{100,000}$$

[3]CHEM. & MET. ENG., vol. 25, No. 6, p. 233, Aug. 10, 1921.

This reduces to the same fraction as that given above. The constant term is introduced merely to give a number of reasonable size.

All such water-resistance tests are made on an oxychloride cement containing 12.5 per cent of calcined magnesite, 25 per cent of ground silica or silex, and 62.5 per cent of standard sand. These ingredients are mixed with magnesium chloride solution of 22 deg. Bé. The reason for the adoption of such a test procedure cannot be discussed in detail here, but some results obtained by the application of this test may prove of interest.

In Table XI are given water-resistance tests made by this method on thirty-one different magnesites in comparison with analytical determinations of different constituents. Careful examination of the table will show that there is no relation whatever between the physical strengths reported and the per cent ignition loss, carbon dioxide, silica, iron and aluminum oxides, or total calcium oxide. It will be noted that the magnesites in the table are arranged in the order of their content of active lime. A study of the table will show that there is apparently no relation between the per cent of this ingredient and the physical tests reported. Experience has shown that other factors in the composition of a calcined magnesite not expressible by chemical analysis have such a vital influence on the strength and permanency of the oxychloride cements resulting that they are apt to obscure any relation existing between lime content and physical strengths when a single sample of magnesite is considered. Only when a sufficient number of determinations are averaged to cancel out these other factors would it be expected that the real relationship would appear.

Such average results are given in Table XII. In this the magnesites are divided into four classes depending on their content of active lime. If the mean values of active lime for each class are compared with the average physical strengths for each class, a definite relationship will at once become apparent. Per cent wet strength decreases rapidly as the content of active lime increases. This relation is brought out perhaps more clearly by Fig. 1, which shows graphically the relation between

TABLE XI. RELATION BETWEEN ACTIVE LIME AND PHYSICAL PROPERTIES—INDIVIDUAL RESULTS

| Magnesite No.	Loss on Ignition	CO_2	SiO_2	R_2O_3	Total CaO	Active CaO $MgCl_2$ Method	Modulus of Rupture, Lb. per Sq.In.			Wet Strength as per Cent Dry Strength	Recovered Strength as per Cent Dry Strength	Classification Factor	Free Lime H_2O Method
							Dry	Wet	Recov.				
1	8.05	5.52	3.12	0.74	3.33	0.78	1,115	519	1,081	43	89	1,990	0.63
2	8.24	3.32	6.27	1.23	3.65	0.97	1,097	495	767	45	70	1,550	0.42
3	7.17	1.58	6.42	0.45	3.14	1.01	1,187	585	948	49	80	2,280	0.44
4	5.98	1.78	5.59	0.61	3.31	1.17	1,197	566	1,000	47	84	2,220	0.38
5	7.92	3.62	5.49	1.14	2.64	1.18	1,633	759	1,726	46	105	3,560	0.46
6	5.98	1.78	5.59	0.61	3.31	1.29	1,197	566	1,000	47	83	2,200	0.38
7	14.44	2.76	2.46	0.71	3.50	1.30	1,012	637	884	63	87	3,500	0.42
8	8.35	3.25	5.07	0.80	3.58	1.44	1,232	642	977	52	80	2,660	0.44
9	10.65	4.07	8.09	1.32	4.34	1.53	1,277	594	1,188	46	93	2,510	0.48
10	6.98	1.68	7.01	0.42	3.64	1.57	1,010	618	854	61	84	3,160	0.48
11	9.23	4.37	5.10	0.72	4.42	1.58	1,336	446	842	33	63	920	0.40
12	9.09	1.54	2.09	1.20	3.40	1.61	1,486	273	604	18	40	190	0.36
13	9.32	4.16	5.82	0.54	4.03	1.62	1,243	672	1,118	54	90	3,260	0.63
14	4.94	1.04	9.23	1.25	3.19	1.62	1,172	569	971	49	82	2,310	0.63
15	5.35	1.90	2.86	0.50	3.15	1.62	1,515	448	1,214	30	80	1,090	0.50
16	7.78	5.73	6.81	....	....	1.65	1,876	519	1,110	28	59	870	0.48
17	11.25	2.08	1.33	1.42	2.49	1.75	1,588	324	1,199	20	71	480	0.46
18	5.54	1.40	2.91	0.90	4.24	2.02	885	481	799	54	90	2,330	0.48
19	3.70	2.75	3.96	0.63	2.76	2.20	1,330	430	686	32	52	710	0.71
20	6.95	2.54	7.65	1.21	3.75	2.27	1,378	97	300	7	22	15	1.01
21	7.91	2.08	1.41	0.59	2.44	2.32	1,580	525	967	33	61	1,050	0.69
22	5.74	3.17	7.14	1.30	5.35	2.32	1,198	110	422	10	35	42	0.55
23	6.31	3.08	9.73	2.42	6.85	2.38	811	416	719	51	89	1,880	1.77
24	9.08	0.58	11.90	1.12	4.43	2.44	1,066	400	758	38	71	1,090	0.08
25	6.65	1.85	5.74	0.33	2.70	2.57	1,436	296	528	21	37	230	0.61
26	8.25	2.42	6.36	0.72	5.60	2.61	1,261	170	441	13	35	75	0.53
27	5.25	2.85	6.10	0.56	4.74	2.71	1,257	385	698	31	56	670	0.42
28	4.65	1.85	5.74	0.33	3.89	2.82	1,691	60	125	4	7	2	0.63
29	3.57	2.22	8.70	1.01	3.71	3.03	1,159	80	276	7	24	14	0.57
30	8.69	3.44	13.34	2.03	4.28	3.07	1,011	252	810	25	80	610	1.11
31	2.95	2.80	3.45	0.88	4.48	3.65	1,604	132	198	8	12	12	0.44
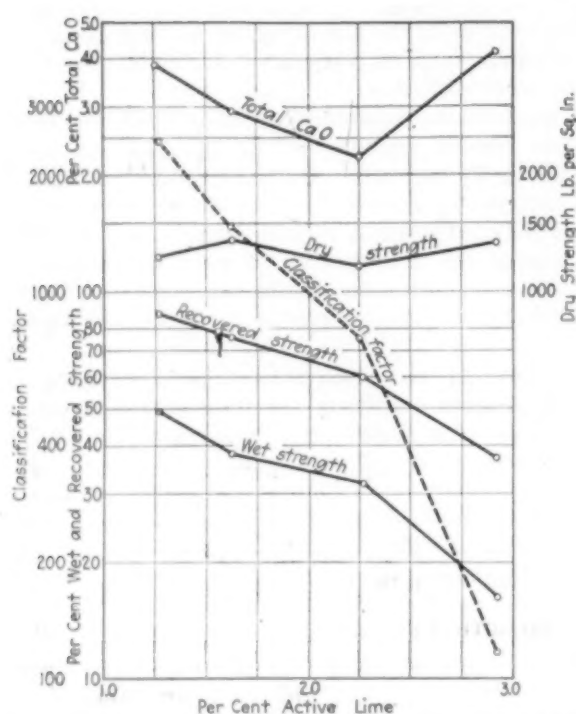
FIG. 1.   RELATION BETWEEN WET AND RECOVERED
STRENGTH AND PER CENT OF ACTIVE LIME

wet strength and recovered strength and per cent of
active lime.   It should be noted here that there is no
apparent relationship between dry strength and active
lime and also that if per cent total calcium oxide were
used as a basis for comparison no relation of any type
would be apparent.   A rapid drop in value of the class-
ification factor with increased content of active lime
should also be noted.

TABLE XII.   RELATION BETWEEN ACTIVE LIME AND
PHYSICAL PROPERTIES—AVERAGE RESULTS

Per Cent Active Lime	Mean Value	Wet Strength as per Cent	Recovered Strength as per Cent	Dry Strength, Lb.	Per Cent Total CaO	Classifica-tion Factor	Per Cent Free Lime
0–1.5	1.27	49	84	1,221	3.85	2,460	0.45
1.5–2.0	1.62	38	74	1,390	2.95	1,490	0.49
2.0–2.5	2.28	32	60	1,182	2.23	730	0.87
2.5–4.0	2.92	16	37	1,234	4.20	116	0.62

In both Tables XI and XII the per cent of free lime,
as indicated by the water solubility method previously
described, is given for comparison.   It is evident that
this determination bears no direct relation to physical
properties of the oxychloride cements.

Some explanation for the phenomena noted must be
sought.   The presence of active lime in a calcined
magnesite will result in two different actions.   In the
first place calcium chloride will be introduced into the
magnesium chloride solution.   The effect of such an
introduction on physical strengths is brought out from
Table XIII, which shows that when any large amount

TABLE XIII.   EFFECT OF CALCIUM CHLORIDE ON PHYSICAL
PROPERTIES OF OXYCHLORIDE

Per Cent CaCl₂ Added to MgCl₂	Dry	Modulus of Rupture Wet	Recovered
0	1,158	604	828
5	936	432	768
10	570	114	240

of calcium chloride is added a marked reduction in the
strength and water resistance of the oxychloride cement
appears.

An even more important feature affecting the physical
strength is the reduction in gravity of chloride solution

which will be brought about by active lime.   The amount
of water in the mix will remain essentially unchanged,
but magnesium chloride will be removed by chemical
action and the resulting solution will have a lower con-
tent of this salt than that originally used for the mix-
ture.   Such a reduction radically reduces the strength
and water resistance of oxychloride cements, as is shown
from Table XIV, which gives the average results of
reduction in chloride strength from 22 to 20 deg., Bé. on
five different magnesites.

TABLE XIV.   EFFECT OF CHLORIDE STRENGTH ON PHYSICAL
PROPERTIES OF OXYCHLORIDE CEMENT

Gravity of Chloride Solution, Deg. Bé.	Average of Five Magnesites — Modulus of Rupture —		
	Dry	Wet	Recovered
22	1,453	616	890
20	1,293	417	827

In the 1:2:5 mix employed for these tests, in which
approximately 1.3 c.c. of magnesium chloride solution
will be required for each gram of magnesium oxide used,
the presence of 1 per cent of free lime in the calcined
magnesite will result in a reduction in gravity of the
magnesium chloride solution of approximately 1 deg.
Bé., together with the introduction of an amount of
calcium chloride equal to about 3 per cent of the
MgCl₂6H₂O present.   When the summation of these two
effects is considered, it is not at all surprising that the
influence of active lime is as striking as it is.

Although a definite relation has been found to exist
between active lime content and physical properties of
an oxychloride cement produced from a given magnesite,
it should be thoroughly understood that such an effect
is observable only when results from a large number of
magnesites are averaged.   Important as the effect is,
it can very easily be overbalanced by other factors.   It
is not safe, accordingly, to say that a magnesite having
any definite precentage of active lime is dangerous or
that one containing active lime lower than certain
amounts will be a good product.   The results should not
be taken as any argument for the adoption of chemical
tests for calcined magnesite, but merely as an additional
indication of the necessity of the investigation of the
physical properties of the oxychloride cements pro-
duced from a given sample of plastic calcined magnesite
before any definite conclusion as to the quality of this
material can be reached.

SUMMARY

Methods for determination of "free" and of "active"
lime in plastic calcined magnesites have been indicated,
and the distinction between total lime and active lime
in such a material brought out.

A relation between active lime content of calcined
magnesites and physical properties of the oxychloride
cements produced from them has been brought out.

The relationship between active lime content and
physical properties of oxychloride is apparent only when
average results from many samples are considered.
Other factors may completely obscure the relation in a
test on a single sample.

Active lime content is accordingly not a definite
indication of poor quality in a magnesite, although a
magnesite containing active lime in large amount should
be regarded with suspicion.

Physical tests of oxychloride cements must still be
regarded as the only safe criterion of the quality of
magnesites used in the oxychloride industries.

National Kellastone Co.
    Chicago, Ill.

Internal Service-Strains in Steel*

Discusses the Effect Which Forces and Movements Taking Place Within the Metal Itself, Between Crystals and Even Between Atoms, Induced by Conditions Other Than External Loading, May Have Upon the Successful Employment of Steel in Industry

By JAMES E. HOWARD†

DISCUSSIONS upon the properties of materials have seldom taken so important a direction as that which is called for under the present general discussion. In general, the ultimate object of employing the materials of construction is to utilize their ability to resist stresses. Their value depends upon their ability to endure successfully stresses of different degrees continued over different intervals of time, having reference to the external loads which are imposed upon them.

Practically all of the materials of construction are affected by internal strains. Opposing internal strains may be present in individual members when apparently they are in a state of repose; that is, when no external forces are acting upon them. These internal strains are no less real than those which are the direct results of external loads. The resultant strains in any given member, under working conditions, is the algebraic sum of the internal strains and those which are caused by external loads.

STRAINS MAY BE RESIDUAL OR ACQUIRED

Under many conditions of service the state of internal strain of the material demands consideration. This is peculiarly the case with steel rails which are exposed to destructive forces and which acquire in service internal strains of high degree. Bridge members acquire internal strains, cooling strains during fabrication of component parts and strains when they are assembled, to which are finally added those due to dead and live loads.

The original properties of materials are generally made the subject of careful determination, while scant consideration has been given those phases through which materials pass under exposure to service conditions, involving the introduction of internal strains which at times culminate in rupture. These original properties may be imparted to steel by various means, by chemical composition, by heat and by mechanical treatment. The ability of the steel to resist different stresses in service is not definitely shown by the values of the original properties. It is commonly assumed that a favorable relation exists between the original properties and service stresses, when certain initial properties are imparted to the steel, furnishing a reason for imposing exacting requirements upon their original state, although the relations have not been clearly established.

It is a very welcome diversion therefore to have attention invited to the subject of internal strains and the effects of prolonged stresses, matters which are so intimately connected with the safe and proper use of materials. It is somewhat difficult nevertheless in taking up a subject so comprehensive as the present one to choose the features to be commented upon. Attention, however, will be directed to certain features which are among those less frequently taken into consideration in discussions upon the physical properties of steel. Reference will only be made to examples which have come within the experience of the writer.

STRENGTH DEPENDS ON CONDITIONS OF LOADING

In dealing with steel a query is at once suggested; namely, what constitutes the maximum range in strains which steel will endure, under either temporary or permanent loads and without loss of integrity. Temporary strains of tension in steel music wire have been shown amounting to 0.015 per unit of length. Under stress of compression, hardened steel endures a strain of 0.020 per unit of length. These strains represent stresses of 450,000 and 600,000 lb. per sq.in. respectively. They stand as extreme examples of elastic extension and compression which have come to notice, and are far beyond any elastic strains made use of in the arts. Music wire, in the upper octaves of a pianoforte, probably affords an example of maximum working stresses under which steel is placed for long continued periods, strains of about 0.006 per unit of length, more or less.

Examples of reversed strains, in the same member, have not been observed approaching those which steel has displayed while under stresses in one direction only. Steel subjected to alternate stresses of 50,000 lb. per sq.in. tension and compression each has shown apparently complete restoration in length after release of stress, thus showing an aggregate elastic movement of 0.003⅓ per unit of length. Its ability to display this aggregate movement was impaired when over-straining loads in either direction were applied; loads which caused the introduction of permanent sets of either tension or compression.

Herein is observed the effect of a structural change resulting from stresses which permanently disturb the relative positions of the component parts of the steel. It appears to be a characteristic of the effect of alternate stresses that a reversal of direction of strain is attended with less total or aggregate elastic resilience than steel is capable of displaying when strained in one direction only. It is doubtful whether steel will be found which will endure long continued alternate stresses, in which the strains exceed a small percentage of the aggregate strains of tension and compression in separate members. In the experience of the writer the limiting stress, under repeated alternate stresses, which steels are capable of enduring 100,000,000 repetitions or more is in the vicinity of 45,000 lb. per sq.in.

In commenting upon this feature years ago, Shreve inferred from the results of Wöhler and Spangenberg that 30,000 lb. per sq.in. was the limiting stress for irons.

STRENGTH IN CUBIC COMPRESSION

Judging from experience with other materials and noting also that no change occurs in the physical properties of mild steels after exposure to cubic compression several times the elastic limit in tension, it is inferred that steels will endure cubic compression without limit. Destruction of integrity of a material results from separation of the adjacent particles, but that integrity does not admit of being impaired by forces of compression when received simultaneously in three directions, however great those forces may be. It follows that the maximum intensity of a force of compression may be very great without injury provided there is a progressive graduation from the center of effort to the periphery of the stressed area. For this reason intense impinging pressures such as those which occur between the head of a rail and the tread of a wheel, although injurious, are less damaging to the metal either of the rail or wheel than such pressures would be under conditions of uniformly distributed stresses.

In a sense, the most stable condition in which steel exists is the annealed state. It was early observed that the value of the modulus of elasticity of steel was modified when the metal was materially overstrained and had received a substantial permanent set. This value is temporarily lowered. A stress-strain curve with the steel in this condition shows an area of lost work, between ascending and descending stresses. A struggle apparently goes on within the steel to recover from this overstrained state, and after the lapse of a few days or weeks the normal value of the modulus is regained.

INTERNAL STRAINS IN FORGED OR ROLLED STEEL

The denseness of steel is modified by treatment. Heating and quenching, annealing and cold working, all result in changes in volume. It has even been found that changes in the dimensions of forgings take place more in one direction than another. By means of a strain gage, forgings have been found to contract when annealed more in length than in lateral directions. In this behavior of forgings there appears to be evidence of an interstructural or intermolecular state of strain which affects the general mass of the metal. This is not the usual manner of strain in which one portion of the volume in a state of internal compression is balanced by another part of the volume in a state of tension, but a diffused state of strain in which the microconstituents may play the principal parts.

Not unlikely a relation may exist between the viscous resistance of steel at forging temperatures and this interstructural state of strain. The behavior of steel forgings in this respect suggests an interesting line of inquiry.

Internal strains make their appearance in steel cooled from the ingot or cooled after the operations of forging or rolling. The parts first to cool are usually left in a final state of compression, unless modified by complexity of form in the steel member. Earlier strains in the steel, experienced during the period of cooling, are reversed in the cold metal.

Under normal conditions of air cooling, internal strains are modified by the cross-section dimensions of the steel member. Since the acquisition of internal strains is influenced by the rate of cooling, large forgings of compact form are expected to be less affected than forgings or rolled shapes having thin webs and flanges. In steel rails, with thin flanges, internal strains of compression not infrequently reach a magnitude equivalent to a stress of 15,000 lb. per sq.in. In the heads of the heavier rails cooling strains equivalent to 5,000 lb. per sq.in. compression represent ordinary values.

Steel structural members, channels, angles and plates also acquire cooling strains after they emerge from the rolls. Built-up compression members, of which they may form component parts, will initially contain cooling strains of considerable magnitude. Recent examinations of structural shapes have shown the presence of internal strains of compression equivalent to 12,000 lb. per sq.in. This value is three-fourths of the usual allowable stress for compression member in current engineering practice. Since no account is usually taken of the presence of internal strains in structural members exposed to compressive stresses, the omission is worthy of note.

COOLING AND QUENCHING STRAINS

The usual range of internal strains in air-cooled steel members may be greatly extended by accelerated rate of cooling, by exposure to a current of air, by an air blast, or by cooling with water from a medium high temperature, but not so high as to result in thermal hardening. Rapid cooling of steel rails from the finishing temperatures of the rail mill by means of an air blast is capable of introducing internal strains of compression exceeding 40,000 lb. per sq.in. Forgings reheated to about 900 deg. F. and cooled with water acquire internal strains of compression comparable with those resulting from an air blast on rails at finishing temperatures.

Local heating followed by normal air cooling also results in the introduction of internal strains; that is to say, unequal heating of steel, as well as unequal cooling, is a cause for internal strains. By means of an oxyacetylene torch internal strains may be introduced, and changes in dimensions effected at will, either in plus or minus directions, according to the locality on which the torch is applied. The side of the member locally heated finally contracts in length while the opposite side expands. The heated side dilates, is overstrained by the cooler and stronger side and is eventually shortened. Admonitions upon the manner of heating and quenching machine small tools are based upon causes such as here described.

Heating by frictional resistance and quenching by the conductivity of the cold surrounding metal introduce internal strains and lead to the rupture of metals. Brake shoes in railway service furnish familiar examples of such action. The treads of wheels are occasionally affected in like manner. Examples of "wheel-burnt" rails, so called, are numbered by thousands, that is rails which have been intensely heated along elements on the running surface of the head by the slipping of wheels. All phases of heating, quenching and annealing are confined within shallow depths of metal on the heads of those rails, and this occasionally results in rupture. The severe structural effects which may result from wheel burning will be realized upon giving consideration to the difference in the rate of transmission of heat through the cross-section of the rail and the rate of transmission of strains.

It is necessary to exercise care in machine tool operations to avoid the introduction of internal strains. A light feed and depth of cut, employing a tool with a sharp cutting edge, is necessary in the machining of steel in a lathe or planer to avoid the introduction of internal strains. Internal strains of compression are commonly introduced in machine operations. It has been found, however, that excessive cuts and feeds may result in the introduction of strains of tension. Punching and shearing of steel for use in important places has long been objected to. The introduction of high-speed, blue-chip, tool steels has brought about machine tool practice encroaching upon the objectionable features of punching and shearing.

EFFECT OF COLD ROLLING ON STEEL RAILS

The introduction of internal strains of most common occurrence is found in the case of steel rails in railway service. All rails are cold rolled and acquire a state of internal strain resulting from the wheel pressures. Cooling strains resulting from manufacture are present in the rails when placed in the track. These strains in part remain unaffected by subsequent conditions of service. Those in the flanges of the base commonly remain undisturbed. It is quite a different affair, however, in the head of the rail. Here the original cooling strains are immediately augmented by the wheel pressures. Internal strains in the rail head next the running surface not infrequently attain a magnitude equivalent to 20,000 lb. per sq.in. stress. The internal strains next to the running surface are those of compression.

Necessarily there must be strains of tension in some part of the cross-section of the rail to furnish the required reaction. They are found along the central zone of the head, where the measured values have reached 8,000 lb. per sq.in. tension.

This condition acquired by the rails in the track is the explanation, in the opinion of the writer, which accounts for the development of transverse fissures. The most strained fibers in tension in the head are interior fibers. Transverse fissures commonly have their origins in eccentric position, the majority being located on the gage side of the head. No other common cause has been found to account for the formation of these fissures of interior origin.

SHATTERED ZONES AND BRITTLENESS UNDER CUBIC TENSION

Shattered zones have been found in some rails along the center line of the head and at the junction of the web and the base. No failure has resulted from the shattered zone in the base. It has not been ascertained whether the presence of shattered metal in the head promotes the development of transverse fissures by furnishing a nucleus from which they may extend or on the other hand whether the internal strains caused by the wheel pressures are diffused and expended in the looseness of the central zone when shattered metal is present. Shattered rails are found which have not displayed transverse fissures and transverse fissured rails are met in which there is no evidence of a shattered zone.

These shattered zones appear to be the result of shrinkage strains, acquired when the rail is cooling, after the last pass in the rail mill. The shattered metal does not extend to the hot sawed ends of the rails, but terminates about the same distance from the rail ends as the distance in from the peripheral metal of the head to the shattered zone. This circumstance fixes the period during which these zones are formed.

The idea does not appear untenable that brittleness, in the sense of inability to display permanent extension, may be displayed by steel at any temperature, under conditions of cubic tension. The only opportunity for steel to reach such a state, in which there are simultaneous strains of tension in three directions, seems to be during the operation of cooling at the period when the peripheral metal has reached a state of compression and exerts tension on the interior. At some stage during the operation of cooling there is a reversal of strain from tension to compression in the peripheral metal. The higher the temperature at which this reversal takes place, the lower the prevailing tensile strength of the steel. At the finishing temperature of rails, while there is considerable viscous resistance to the steel, it then has but little tensile strength. Even with a lowered modulus of elasticity at finishing temperatures only a minute strain would seem necessary to separate adjacent particles and prove adequate to cause these shattering cracks. Since all forged and rolled shapes are subject to cooling strains of this kind, it is obviously desirable to clear up matters connected with the phenomenon. As the case now stands, shattered zones have been found in some rails and not in others. Those which have displayed this phenomenon, by chance or otherwise, have been of the harder grades of steel.

EFFECTS OF SURFACE DEFECTS

A slight surface defect or interruption in continuity is known to have a serious effect on steels exposed to repeated alternate stresses, leading to premature rupture. This is quite evident from the failure of steels in which the structural defect was located remote from the plane of maximum fiber stress. The rupture of steel occurs when two adjacent particles are separated beyond their radius of action or molecular bond, whatever descriptive term may be used in this connection. Progressive fractures develop under such conditions. Since the presence of a surface defect produces a result similar to an increased fiber stress on the metal as a whole, it is inferred that an actual increase in fiber stress is experienced in the vicinity of the defect. Carrying the inference one step farther, it appears reasonable to believe that internal strains may augment those of external origin, the algebraic sum of the two representing the actual fiber stresses which affect the steel. Carrying the inference still farther, although now approaching a debatable state, it may be argued that actual separation of adjacent particles occurs when and only when the local strain between them reaches a maximum and that this maximum has a relation to the original tensile strength of the steel. In support of this last inference is the behavior of steel under repeated alternate stresses conducted at different temperatures. At a blue heat, in the range of 400 deg. and 600 deg. F., at which period the tensile strength is above that at ordinary temperatures, steels under repeated stresses endure several times the number of repeated loads which they sustain at atmospheric temperatures. That is at the time of increased tensile strength there is an accompanying increase in its endurance of repeated stresses.

A field but partially explored presents itself in tracing the phases through which steels pass in their approach to the final stage of rupture, involving among

others the query at what stage and by means of what treatment can the progress of rupture be arrested and the steel restored to its original state. Unlimited endurance, in a practical sense, is now experienced by limiting the fiber stresses within a certain range. High initial physical properties are imparted to steels by special treatment, heat and mechanical. The question of ultimate endurance is not fully met by subjecting steels of exceptionally high original properties to a comparatively small number of alternate stresses. Results already gained are gratifying but they still leave undetermined basic questions pertaining to long continued stresses.

Stress-strain curves under loads once applied and advanced until rupture takes place, as performed in ordinary tests by tension, are practically straight lines until the elastic limit is reached. Early sets, if such appear, may conjecturally be attributed to the influence of internal strains pre-existing in the steel, in localities where the elastic limit is reached prior to that of the general mass of the metal. There is lack of harmony between the opinion often expressed that a permanent set occurs under every stress however small it may be, and the example of music wire sustaining stresses far above 100,000 lb. per sq.in. over periods of years and with the ability to sustain a temporary stress of 460,000 lb. per sq.in. tension.

Evidence does not seem to have been presented in support of the statement that any stress however small will cause a permanent set in steel, and that perfect elasticity or complete resilience after the application of a force of tension does not constitute a fundamental property in steels. The limited consideration which has been given to the matter of internal strains is believed to account for certain popular impressions.

In conclusion, it may again be remarked that attention has commonly centered upon the original properties and characteristics of steels, and the means by which these original properties are modified, overlooking the wide range of conditions which affect the endurance of the metal, the phases through which steels pass under conditions of service, and which lead in the direction of ultimate rupture.

German Sales of Potash

According to a recent dispatch from Berlin 419,000 metric tons of potash (K_2O) was sold in Germany between Jan. 1 and July 31, 1921. It is reported that the inland prices received did not cover the cost of production and that the profits on foreign sales of the same material were less than in the like period of 1920.

Phosphates in Morocco

The first shipment of 300 tons of phosphates has just been made from Onedzem according to a dispatch from Casablanca, Morocco, dated Aug. 2. This is regarded as an industrial event of prime importance, in view of the enormous beds of this material now awaiting development in the Onedzem district.

Rumania Abolishes Export Duties on Some Chemical Products

A decree issued by the Rumanian government on Aug. 1 states that export taxes on the following chemical products have been abolished: alcohol, glucose, calcined and crystallized soda, sulphuric and acetic ethers, amylacetate and crude sulphuric acid.

Comparative List of Imports and Exports of Chemicals for Fiscal Year Ended June 30, 1921

Imports decreased 43 per cent, exports decreased 25 per cent during the fiscal year 1921 compared with 1920, according to official figures of the Department of Commerce just made public. An analysis of imports shows that crude materials fell from $2,141,000,000 in 1920 to $1,051,000,000 for the year just closed, indicating that mill consumption fell off materially during 1921, hence the lessened demand for the raw materials of foreign countries. Imports of crude foodstuffs and food animals fell from $622,000,000 to $452,000,000; of manufactured foodstuffs, from $891,000,000 to $842,-000,000, or a decline of $219,000,000 in our purchases of foreign products.

The emergency tariff act became effective May 27. During May we imported about $62,000,000 worth of foodstuffs, crude and prepared, while in June the total of these imports was $40,000,000.

Manufactures for further use in manufacturing fell from $801,000,000 to $543,000,000, again reflecting the depression in industry. But imports of completed manufactures scored a decrease of but $1,000,000, or from $745,000,000 to $744,000,000 in value. The prewar average was under $450,000,000.

On the export side of the sheet crude materials decreased from $1,969,000,000 to $1,288,000,000, the two years compared. A falling off in sales to other countries which have been fairly well stocked with American crudes was somewhat balanced by increased purchases on the part of Germany. Crude foodstuffs increased from $626,000,000 to $979,000,000, being the only group to show an increase over 1920. Manufactured foodstuffs fell off from $1,514,000,000 to $779,-000,000. Partly manufactured goods decreased from $991,000,000 to $687,000,000, while completed manufactures showed a decrease from $2,835,000,000 to $2,643,-000,000.

To sum up, our imports decreased from $5,238,000,000 in 1920 to $3,654,000,000 in 1921, while our exports decreased from $8,109,000,000 to $5,516,000,000. This includes the miscellaneous group and foreign merchandise exported.

Handbook on Shellac Industry in India

The Government of India has issued a "Report on Lac and Shellac" as part of "Indian Forest Records," which Trade Commissioner C. C. Batchelder believes to be very useful and of interest to users of shellac. It is a comprehensive book, the result of investigations made into the sources of supply, methods of production, manufacture, transportation and distribution, fluctuations of prices and volume of exports. It not only shows in a colored map the places where the lac is produced, but presents graphically in charts the variations in London and Calcutta prices from 1901 to 1919, with the London stocks and the effect of large stocks upon Calcutta prices.

Explanations are given of the variations in quality due to methods of preparation and cultivation, together with much other technical information, such as the way to restore the solubility of relatively insoluble shellac.

Of immediate practical use are the lists of the principal manufacturers, dealers, and exporters in the different lac centers. There is also a list of other literature on the subject.

Decision in Bakelite Patent Suit

THE U. S. District Court, Eastern District of New York, on Aug. 2, 1921, rendered its decision in the patent suit of the General Bakelite Co. of New York vs. the General Insulate Co. of Brooklyn. Three Bakelite patents relating to various uses and applications of synthetic resins were involved and all were declared valid and infringed.

The original bill of complaint was filed by the Bakelite Company on Sept. 18, 1917, and the trial, which began on March 31, 1919, was not concluded until June 22, 1919. The counsel for the General Bakelite Co. were Charles Neave and Maxwell Barus, of Fish, Richardson & Neave, and C. P. Townsend, of Byrnes, Townsend & Brickenstein. John H. Lee, of Dyrenforth, Lee, Critton & Wiles, and J. Edgar Bull, of Gifford & Bull, were counsel for the defendant. The trial was conducted before Judge Thomas I. Chatfield.

It will be recalled that in a previous patent suit[1] against George J. Nickolas & Co. of Chicago, where three other Bakelite patents were involved—namely, Nos. 954,666, 1,018,385 and 1,037,719, covering specifically the manufacture of Bakelite varnishes and solutions—the General Bakelite Co. obtained a decree adjudicating the validity and infringement of these patents.

The General Insulate Co. of Brooklyn is engaged in a molding business and produces insulating material resembling hard rubber. It uses as its raw material the synthetic resin, purchased from the Redmanol Chemical Products Co. of Chicago, either in the form of a fine powder or as hard, brittle sheets. The case necessarily involved consideration of the character of the Redmanol product, and that company, although it was not a party to the suit, stood behind the defendant in all matters relating to patentability. To quote from the opinion of the court, "the Redmanol company has as freely and fully presented its evidence as if the action had been against the Redmanol company, for infringement of the plaintiff's patents, in the manufacture of the synthetic gum itself."

CLAIMS OF THE PATENTS IN ISSUE

The suit was brought on the following United States patents: The so-called heat and pressure patent, No. 942,699, which grew out of an application filed July 13, 1907; the indurated product patent, No. 942,852, which was a division of the application of the previous patent; and the so-called mixture or molding patent, No. 939,966, which was issued upon an application filed Jan. 28, 1909.

The following claims were in suit in the first patent:

"1. The method of producing a hard, compact, insoluble and infusible condensation product of phenols and formaldehyde, which consists in reacting upon a phenolic body with formaldehyde, and then converting the product into a hard, insoluble and infusible body by the combined action of heat and pressure."

"2. The method of making articles containing an insoluble and infusible condensation product of phenols and formaldehyde, which consists in reacting upon a phenolic body with formaldehyde, producing thereby a reaction product capable of transformation by heat into an insoluble and infusible body, forming the article from said reaction product, and rendering the article hard, insoluble and infusible by application of heat and pressure."

"4. The method of making articles containing an insoluble and infusible condensation product of phenols and formaldehyde, which consists in reacting upon a

[1]CHEM. & MET. ENG., vol. 13, No. 7, p. 711, July, 1915.

phenolic body with formaldehyde, producing thereby a reaction product capable of transformation by heat into an insoluble and infusible body, forming the article from said reaction product compounded with a filling material, and rendering the article hard, insoluble and infusible by application of heat and pressure."

The claims in issue in the next patent are 5 and 6:

"5. As a new composition of matter, wood cell tissue impregnated with an infusible and insoluble condensation product of phenol and formaldehyde."

"6. As a new composition of matter, a fibrous or cellular material impregnated with an infusible and insoluble condensation product of phenol and formaldehyde."

The claims of patent No. 939,966 in suit are:

"1. The method of molding articles which consists in comminuting a partial reaction product of phenol and formaldehyde, molding the mass under pressure, and transforming the same into an insoluble and infusible condensation product.

"2. The method of molding articles which consists in comminuting a partial reaction product of phenol and formaldehyde, molding the mass under pressure, and transforming the same in the mold into an insoluble and infusible condensation product.

"3. The method of molding articles, which consists in preparing a comminuted mixture of a partial reaction product of phenol and formaldehyde and a filling material, molding said mixture and transforming the partial reaction product into an insoluble and infusible final condensation product."

The prior patents relating to the subject of molding and hot pressing are dismissed with the statement:

They taught nothing as to the creation of synthetic condensation products, and left the prior art with mere knowledge of melting, dissolving, solidifying, pressing, turning, boring, polishing and cutting materials, which proved the demand for substances which were never thought of until phenolic condensation products were discovered.

THE MANASSE, LUFT AND STORY PATENTS

Detailed consideration, however, was given to the few patents for the prior art of making synthetic compounds of phenols with formaldehyde. Among these the ones of particular interest are the patents of Manasse, Luft and Story. The following paragraphs referring to the history and extent of these patents are abstracted from Judge Chatfield's opinion:

The earliest patent that should be considered is that issued to Otto Manasse, in the United States, No. 526,786, Oct. 2, 1894. Manasse was seeking to describe a method or process of producing phenol-alcohols by using alkaline or neutral condensing agents, in aid of the reaction of formaldehyde on phenol or phenol-like substances. After mixing the phenol dissolved in the alkaline or neutral condensing agent with formaldehyde, and acidulating the resultant mixture, he separates the oxybenzylalcohol from the watery solution by extraction by ether. He then evaporates the solution so as to obtain a semi-fluid mixture which is treated with steam, thus driving off the residues of formaldehyde and phenol which have not entered the reaction. On cooling and filtering a resinous body is left, which apparently is the synthetic product in which both the plaintiff and the defendant in this case are interested. But Manasse rejects this resin and treats further the solution in order to obtain crystals, which in turn, when dissolved in benzine show a separation of oxybenzylalcohol from the parahydroxy-benzylalcohol which remains in the form of an amphorous powder in the solution.

Luft states (U. S. Patent 735,278, Aug. 4, 1903) that he is seeking to obtain a plastic compound, which in the German patent he calls a "resinous mass," by making use of the "known fact that upon boiling phenols with aldehydes, and especially with formaldehyde, in the presence of acid, a mass results which when fresh is viscous and very plastic," and is capable of use in the arts.

Luft apparently began to work with the resinous mass which Manasse filtered out and discarded.

Luft's process is expensive, and he never, so far as his own knowledge or the disclosure of his patent is concerned, got beyond the fusible and soluble state. It is

evident, as was shown in court, that present knowledge of the art in the hands of an expert makes it possible so to manipulate the Luft process as to produce an insoluble and infusible final product, but Luft never did this nor taught it by his patent disclosure alone.

The Story patents, British, No. 8,875, of 1905, French, No. 353,995, of Sept. 25, 1905, and the French Addition, No. 9,861, applied for Sept. 29, 1908, describe the production of a condensation product by the action of aldehydes on phenols. . . .

Story uses commercial carbolic acid containing 95 per cent of phenols with formalin containing about 40 per cent of formaldehyde. He pours his viscous product into molds which he dries at a temperature below 100 deg. C. He takes 50 parts of commercial carbolic acid and 30 parts of formalin and produces a substance which, having once become hard and dry, he states is insoluble in any known solvent and is not attacked by acids or alkalis. He states that in the viscous state it may be dissolved in alcohol, acetone, benzol or other suitable solvent, and furnishes a good varnish for many purposes, from which the solvent may be removed by heat.

The Story patent is particularly interesting because the Redmanol company manufactures and is putting upon the market in large quantities a product which evidently is produced according to the Story description. This result is obtained by long drying and heating, in some instances this period of heating at temperatures around 50 deg. C. lasting for over a year. Story suggests the adding of coloring matter or inert substances while in gelatinous state, and suggests in the addition patent drying at much higher temperatures in order to produce hardness and insolubility.

Experiments during the course of the trial have satisfactorily shown that Story, as well as Luft and De Laire, can be ultimately operated so as to produce the infusible and insoluble substance which is known as "Bakelite C." This is the same substance which is shown and described in the Aylesworth U. S. patent, and which is also referred to in U. S. patent to Stephan, No. 812.608, Feb. 13, 1906, on application filed Dec. 6, 1904. But Stephan was seeking to make an antiseptic powder. His insoluble product was an accidental and not desired substance, obtained if his compound was heated too long. He produced an acid product, and certainly was not teaching the production of the insoluble substance, nor did he anticipate any of the other patents under consideration.

BAEKELAND'S PATENTS

The earliest application of any one of the Baekeland patents was Feb. 18, 1907, and the public description of Baekeland's researches was made in 1909, when various articles were read before the New York Section of the American Chemical Society, and printed in the *Journal of Industrial and Engineering Chemistry* during that year. These dates will become of importance when we consider that the Baekeland patent involving the use of hexamethylenetetramin, which patent was in interference in the Patent Office with applications by Redman, Goldsmith and Steinmetz, and out of which interference a patent was issued to Goldsmith for the so-called dry hexamethylenetetramin method, and to Baekeland for the wet hexamethylenetetramin method. The date is also important in connection with the defendant's claim that Baekeland did not know of the prior art patents when he applied for the heat and pressure patent in 1907. But he discussed these patents in his amendments of March 17, 1908.

Evidently Baekeland was aware of the chemical formation of hexa as early as the proceedings in the Patent Office resulting in Patent No. 942,809, which was issued Dec. 7, 1909. He specifies the use of ammonia as early as October, 1907 (application No. 397,560). There seems to be no reason why his patent No. 1,038,475 should be held invalid because it makes use of certain knowledge described in a co-pending application, even though that co-pending application was of an earlier date.

Even if Redman was entitled to a valid patent for the description of the preparations used by him in the so-called dry hexa method, the defendant using the Redman product would still be liable to a charge of infringement of the patents in suit, whether the hexa be added in a two-step or a one-step process, or in a wet or dry reaction. But the two-step process has in some respects a commercial advantage.

It is also urged that the use of hexa does not in any event infringe the Baekeland patents calling for use of formaldehyde and ammonia. This is a mere verbal argument, as hexa is well within the limit of equivalents but may still be the basis for an improvement of the method patent.

The defendant seeks to escape the charge of infringement by urging the defense presented by the Redmanol company, that hexa was not covered or disclosed by the specifications and claims of any of the Baekeland patents, until Patent No. 1,038,475, and that the use of hexa by Redman constituted a new invention, giving him the right not only to manufacture synthetic reactive gums, with this substance and with carbolic acid, but also to make the various products by the use of dyes and fillers and the employment of molding processes, which Baekeland has attempted to obtain by the patents in suit, and the others described in this case.

FORMALDEHYDE AND AMMONIA EQUIVALENT TO HEXA

As has been stated in his earlier patents, Baekeland discloses the use of substances engendering formaldehyde. It is apparent that hexa is immediately formed upon the introduction of ammonia and formaldehyde. The independent discovery by Redman of the possibility of using hexa, in order to avoid the necessity of drying out the water or moisture remaining in the original reaction product, was antedated by Baekeland's writings and patent specifications, which specifically claim ammonia and the substances engendering ammonia as a part of the Baekeland series of inventions. Redman's invention is therefore dependent upon his methods of manufacture at atmospheric pressure and with a dry compound of formaldehyde and ammonia, rather than from the use of hexa as such.

The use of hexa, therefore, does not get the synthetic gum outside of the Baekeland disclosures and claims. If the defendant makes use of the processes patented by Baekeland, when applied to the substances described by Baekeland, in the production of the commercial material covered by the Baekeland inventions, then it cannot escape the charge of infringement by showing that this material was produced by the Redmanol company with hexa, instead of with formaldehyde and ammonia separately. In other words, hexa is but an equivalent for formaldehyde and ammonia, and the defendant company is using this equivalent in carrying out the process of the Baekeland patent. In this sense the defendant is in a position analogous to a contributory infringer if the Redmanol company were a primary infringer.

CONTENTIONS OF THE DEFENDANT

The defendant contends that the specifications and claims of the heat and pressure patent (No. 942,699) show only, and that the evidence in the case proves that Baekeland had in mind only, the use of counter pressure to prevent violent expulsion of ammonia. It is claimed that he later attempted to include molding pressure, when he realized the need of securing the chemical reaction during the molding and heating process. But while the original claims were not as broad as those finally allowed and were evidently drawn without any attempt to include in words the molding pressure, the language of the specifications shows clearly both understanding of the need and use of molding pressure, and indicates Baekeland's intent to include it in his claims. His subsequent amendments were therefore allowable and there is no reason for limiting the valid range of the patent as issued.

In a similar way, the defendant argues that the only novel feature claimed in the indurated material patent (942,852) as originally presented, was to secure the removal of moisture during an old or well-known reaction for the purpose of impregnating or hardening wood. The separation of water was an essential step, but was not the only one disclosed, and the specifications fully support the claims as finally allowed. One of the materials to be indurated was cellular wood flour, and the impregnation and induration was had in order to make this into blocks or solids. The history of the patent in the Patent Office shows that Baekeland appreciated, at least, the possibility of claiming more than was expressed by the apparent understanding of the examiner and the present contention of the defendant.

The claims are valid and cover molding, with wood flour, and coloring material.

Patentability having been shown, the claims upheld in form and the defendant proved to have infringed, the plaintiff may have a decree.

The Chemistry, Manufacture and Uses of Nitrocellulose

History of Nitrocellulose — Relation to the Chemistry of Cellulose — Comparison of Early and Modern Methods of Manufacture—Military Demands for Smokeless Powder and Peace-Time Uses in Pyroxylin Plastics, Artificial Silk and Leather, in Medicine and Photography

By HUGO SCHLATTER

Formerly Chief of Chemical Products Division, Hercules Powder Co.

THE history of modern high explosives may be said to date from the middle of the last century, although picric acid and some of the fulminates were discovered much earlier. The early history and the discoverers of these products are therefore well known from contemporary literature, and in this respect they differ a great deal from the oldest explosive, black powder, whose history is shrouded in mystery. The year 1846 saw the discovery of both nitroglycerine and guncotton or nitrocellulose, both of which have played and are still playing such an important rôle in human history.

It is true that Braconnot and Pelouze had nitrated starch and paper some years earlier with nitric acid alone, but Schönbein, of Basel, first prepared nitrocellulose from absorbent cotton by means of a mixture of nitric and sulphuric acids, and realized its true significance and value.

A few weeks after this discovery the German Böttger obtained the same result and the two inventors combined to exploit the product. Schönbein had great hopes for his nitrocellulose. In a letter to Faraday he said that he expected that it would soon displace black powder as a propellant for firearms. It was many years, however, before this hope was realized, although a number of plants were put up in short order.

The first guncotton plant was erected in the same year at Faversham, in England, but in July of the next year the whole plant was destroyed by an explosion, with the loss of twenty-one lives. In 1848 similar accidents occurred in the French factories at Bouchet and Vincennes. The result was that its manufacture was prohibited and that the German Confederation refused to purchase the process. The inventors succeeded, however, in selling their secret to Austria and two plants were operated under the direction of an artillery officer, Baron von Lenk, until 1862 and 1865, respectively, when they also blew up and put a stop to further work there. Although Lenk had been extremely careful to purify his guncotton by washing for two weeks in water, boiling with soap and finally treating it with waterglass, his accidents as well as the previous ones in England and France were due to insufficient stabilization rather than from incomplete neutralization of the acids.

DIFFICULTIES CAUSED BY INSTABILITY

In the meantime an English chemist, Sir Frederic Abel, had come to the conclusion that the instability was due to traces of acid retained so tenaciously in the fine capillary of the cotton fiber that simple washing or neutralization with alkaline solutions did not completely eliminate them. In order to reach these traces of acid he broke up the fibers by pulping them in the beating engine of the paper industry. He also devised a test, still known as the Abel heat test, for revealing the smallest traces of acid. Beating or pulping of the nitrocellulose is still practiced, although it is now realized that this does not remove all causes of instability, as will be shown later. In 1865, when Austria stopped manufacturing guncotton, England had two plants, one at Stowmarket and one at Waltham Abbey. The latter was under Abel's management and had in 1872 a production of 250 tons.

Aside from the troubles due to instability, there was another reason why guncotton did not immediately displace black powder as a propellant. It was too brisant —i.e., its rate of detonation was too great—and could not be sufficiently controlled, even by pressing it into solid blocks under heavy hydraulic pressure, to make it safe for use in rifle or cannon. Its chief military use was, therefore, as a charge for mines and torpedoes.

EARLY USES FOR NITROCELLULOSE

In the meantime nitrocellulose has found uses in the peaceful arts, and the developments here resulted later in serviceable nitrocellulose powders. Schönbein himself had observed that by varying the conditions of nitration he was able to obtain nitrocellulose insoluble, partly soluble or entirely soluble in a mixture of ether and alcohol. As early as 1848 Maynard made use of this solution in medicine under the name of collodion, which is still used as a dressing for wounds. In 1851 Scott Archer introduced the use of the same solution in photography. From that time on the use of nitrocellulose, or pyroxylin as it was generally called in the industry, increased rapidly as new solvents were discovered. In 1869 Hyatt obtained his patent covering the use of camphor as a latent solvent or plastifying agent for pyroxylin and thereby laid the foundation for the present enormous celluloid industry. It is true that Parkes and Spill had previously used camphor and camphor oil in nitrocellulose solutions to obtain a plastic film, but Hyatt depended on heat and pressure to develop the latent solvent powers of the camphor. Another extremely important patent is that of Stevens covering the use of amyl acetate, which inaugurated the lacquer and artificial leather industries that have since reached such huge proportions.

In working with these industrial plastics it was found that they burned with comparative slowness. This observation led the French chemist Vieille to the development of a completely gelatinized nitrocellulose powder in 1886. Nobel, who had invented dynamite, two years later (in 1888) patented smokeless powders consisting of nitroglycerine and nitrocellulose. From that time on these two types of nitrocellulose powders slowly but surely pushed black powder out of the place it had held in military affairs for centuries. In this

country, however, it was not until after the Spanish-American War that smokeless powder was finally adopted as the service propellant.

CHEMISTRY OF CELLULOSE AND NITROCELLULOSE

After this somewhat hasty review of the history of nitrocellulose we come to its chemistry. To be strictly accurate, it is not nitrocellulose at all, but cellulose nitrate. Furthermore, nitrocellulose, at least that found in regular practice, is not a definite compound, but a mixture of nitrocelluloses. This is due in part to the fact that the cellulose from which it is made is not a definite compound, but consists of a mixture of more or less mature or developed cellulose. Since both cellulose and nitrocellulose are colloids, whose properties gradually blend into those of the next higher or lower type, it is impossible to separate the different stages by crystallization and difficult if not impossible to separate them by fractional solution or precipitation.

We know very little about the structure or the size of the cellulose molecule. A number of structural formulas have been proposed, but none seems to correspond completely to the facts. The one proposed by Green is probably the most plausible:

$$CHOH - CH - CHOH$$
$$| \quad\quad | \quad\quad |$$
$$\quad\quad O \quad\quad O$$
$$| \quad\quad | \quad\quad |$$
$$CHOH - CH - CH_2$$
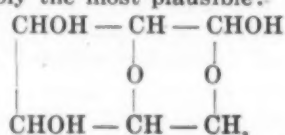
Recent work by Pictet and Sarasin, published in *Comptes rendus* in 1918, promises to throw some light

FIG. 1. FEEDING THE COTTON INTO THE PICKERS PRIOR TO DRYING

on this question. They distilled cellulose under reduced pressure and obtained a crystalline product of the formula $C_6H_{10}O_5$ which forms a triacetate and a tribenzoate and may be the simple or unpolymerized mother substance of cellulose.

The usually accepted formula of nitrocellulose is $C_{24}H_{40-n}O_{20-n}(ONO_2)_n$ where n is 0 for cellulose and ranges from 1 to 12 for the different types of nitrocellulose. Those containing less than 7(ONO₂) groups are commercially unimportant. The most highly nitrated compound containing 14.16 per cent of nitrogen or 12NO₃ groups has not been obtained, because the nitrating acid required for this stage begins to have a denitrating action before the nitration is com-

plete. Military guncotton (13.25 per cent of nitrogen) approaches most nearly to endeka-nitrocellulose, pyronitrocellulose (12.60 per cent of nitrogen) for the manufacture of United States smokeless powder corresponds to deka-, pyroxylin or soluble cotton for lacquers and dopes (12 per cent of nitrogen) to ennea-, and the nitrocellulose for plastics (11 per cent of nitrogen) corresponds to octonitrocellulose.

It is doubtful, however, whether any of these nitrocelluloses have ever been prepared in the pure state; certainly they have not in factory operations. A mixture of a number of them is always obtained, and the art consists in getting as uniform a product as is possible. As a matter of fact, the nitrogen content is not even a good indication of the suitability of a given nitrocellulose for any particular use. While it may be stated that a nitrogen content outside of certain limits will make the product unsuitable for a certain use, a product falling within these limits may be just as unsuitable. For instance, it is possible to make a nitrocellulose of 12.8 per cent nitrogen which is 95 per cent or more soluble in ether-alcohol solution, while another nitrocellulose of the same nitrogen content is less than 15 per cent soluble in this solvent. Nitrocellulose with less than 11.8 per cent or more than 12.3 per cent of nitrogen is generally unsuitable for gelatinizing nitroglycerine, but a nitrocellulose having 12.1 per cent of nitrogen may make just as "leaky" a gelatine. However, the nitrogen content has its importance and gives us valuable indications.

PROPERTIES OF NITROCELLULOSE

There are a great many solvents for nitrocellulose.[1] The commoner ones are the esters of the lower fatty acids and alcohols, acetone and other ketones, commercial wood alcohol (which contains acetone and other ketones), ether-alcohol mixtures, aromatic nitro-compounds, camphor and essential oils. Some of them will dissolve only certain types. Solubility in ether-alcohol mixture, for instance, forms the basis for the classification of nitrocellulose as soluble and insoluble nitrocotton. The latter, containing generally more than 12.8 per cent nitrogen, is also known as guncotton. The former is often referred to as collodion cotton.

Nitrocellulose when ignited burns with great rapidity. It will take fire spontaneously when heated to a temperature of 186 deg. C., or lower, depending on its stability and the rate of heating. Even at ordinary temperatures it will lose nitrogen slowly, although very slowly if properly stabilized. This decomposition is a progressive one, the rate increasing if the products of decomposition are left in contact with it. For this reason stabilizers are added to smokeless powder which will bind the oxides of nitrogen as they are formed. The common stabilizer for pyro powders is diphenylamine. Vaseline, used in British cordite, oils, and various gums have similar properties. When gelatinized, nitrocellulose burns much more slowly. The combustion products vary with the pressure under which combustion takes place. In the open, oxides of nitrogen are always formed and a small carbonaceous residue remains. Under high pressures the combustion is more nearly perfect. It has been shown that a nitrocellulose containing 12.44 per cent of nitrogen should burn completely to carbon monoxide, nitrogen

[1] See Worden, Edward C., "The Nitrocellulose Industry," New York, (1911).

and steam. On account, however, of a small amount of alcohol and stabilizer left in smokeless powder, its nitrogen content has been fixed at 12.6 per cent in order to insure practical smokelessness.

PREPARATION OF THE CELLULOSE

Cellulose is widely distributed in nature. Any of its various forms after proper preparation can be used, but in this country the usual raw material is linters obtained from the cotton seed after the best spinnable cotton has been removed. The great demand for powder during the World War would have made it necessary, if the war had continued another year, to use cellulose prepared from wood, such as the Germans had been doing since early in 1915. No matter what the source of cellulose, it has to undergo considerable preparation in order to make it suitable for nitration. Mechanical impurities have to be removed by dusting, and particles of seed, hull and the natural oils are taken out by boiling under a pressure of about 80 lb. in a 2 per cent solution of caustic soda. During this boiling care has to be taken to insure absence of air, which would cause the formation of oxy-cellulose and later give rise to nitrating troubles. After digestion the soda is carefully washed out and recovered. The cellulose next receives a mild bleaching treatment with bleaching powder, which is again completely removed, and the product is then dried. Chemical pulp made by the soda, sulphite or sulphate process is treated in the same manner and makes a satisfactory raw material for nitrating, especially when it can be mixed with linters, a mixture which is handled more easily than the short-fibered pulp. Wood pulp, however, is more bulky than linters and its use reduces the output.

When the bales of purified cellulose are received at the nitration plant they have to be opened up by being run through pickers. These machines consist either of drums that are studded with teeth or of corrugated circular plates rapidly revolving in opposite directions such as the Cogswell mill. The cellulose is then carefully dried from its natural 6 or 7 per cent of moisture to a content of less than 1 per cent. These preparatory operations are necessary in order that the cellulose will take up the nitrating acids readily and completely. Unopened lumps of cotton or high moisture would cause local overheating, uneven nitration and low yields.

The Government specifications for cellulose for nitrating prescribe an ash content of less than 0.8 per cent, ether soluble or fat content of less than 0.4 per cent, and no more than traces of salts of lime or bleach. Private manufacturers usually also place an an upper limit on the allowable amount of oxy-cellulose as shown by the solubility in 10 per cent caustic soda solution.

EARLY METHODS OF MANUFACTURE

In the original process of nitration earthenware vessels were used that stood in iron troughs through which water circulated for cooling. Only 1 or 2 lb. of cotton was nitrated in each pot. After two or three hours the excess of acid was removed in a hand press and the nitrated cotton, still containing considerable acid, was permitted to stand in covered stoneware pots for twelve hours more to insure thorough nitration. At the end of that time the nitrocellulose was freed from more acid by centrifuging and then washed with water. This method was cumbersome and dangerous, since fuming off occurred quite frequently. The second nitration was soon abandoned and the cotton was left in the acid for twelve hours, after which it was centrifuged and submerged in water. As it was soon found that nitration, especially for the lower grades, could be carried on in a much shorter time, the pots were placed on turntables holding four or eight pots so that one pot after another would be brought up to the centrifugal and the process became a more or less continuous one—i.e., one man would dip cotton all the time and another would wring out the nitrated cellulose as the pot came up to the centrifugal. The
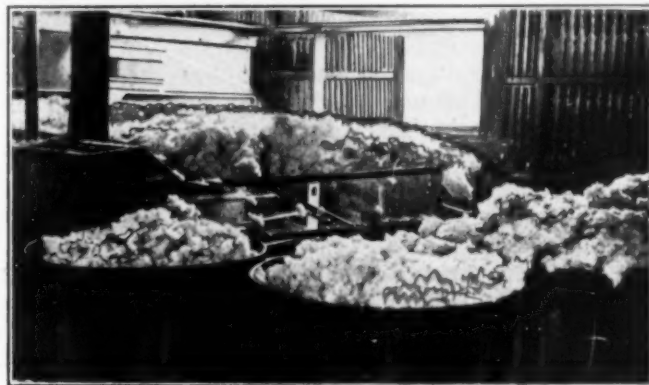
FIG. 2. AFTER THE MOISTURE CONTENT IS REDUCED TO 1 PER CENT THE DRIED COTTON IS WEIGHED INTO CONTAINERS AND SENT TO DIPPING POTS FOR NITRATION

next step was to carry on the nitration in the centrifugal itself. This arrangement is economical only where the time of nitration is quite short, as otherwise the ratio of output to investment would be too small. In order to provide a better and more uniform action of the acid, these nitrating centrifugals are often provided with a slow speed, which induces a slow circulation of the acid through the holes of the basket and back over the top of the cotton.

In the Thompson displacement system nitration is carried on in shallow earthenware pans provided with false bottoms and central outlet holes. The pan is filled with acid and the cotton immersed in it. A perforated plate is then laid over the cotton and cold water slowly run over the top. This water layer effectually seals the acid from contact with air and prevents loss of acid by fuming. After a certain length of time (one to one and one-half hours) more water is allowed to flow in and the acid is withdrawn at the same rate at the bottom of the pan until all of the acid has been displaced—a process which requires about one and one-half hours. This system is most economical in its consumption of acid, provided means are at hand for concentrating the weak acid formed during the last stage of displacement. It is not well adapted to the manufacture of soluble nitrocellulose on account of the difference in solubility between the different layers, since the bottom layer remains in contact with the acid almost twice as long as the top layer.

DESCRIPTION OF A MODERN INSTALLATION

The most modern system provides for the intimate and immediate mixing of acid and cotton in a different way. This system is installed in a four-story building. The top floor houses the motors for driving the machinery. On the next floor below four dipping pots for each unit, provided with agitators, are arranged in

the form of a square. These dipping pots discharge through valved pipes into the centrifugal on the second floor of the building. The centrifugal is discharged through its bottom into a bowl located on the ground floor. A stream of water entering this bowl tangentially submerges the nitrocellulose and carries it through a trap and earthenware flume to the boiling tubs, where the preliminary purification is carried on. The acid fumes, which were very objectionable in the old pot system, are sucked away by a fan from each dipping pot and each centrifugal. Occasionally there is a fume-off or "fire," which may be caused by foreign material in the cotton or a drop of oil or condensed moisture dropping into the centrifugal. In such a case the whole house is filled with fumes and the operators have to take refuge on the balconies that run the length of each floor. For these emergencies large exhaust fans with airplane propellers are provided, which clear the atmosphere in the course of a few minutes, thus confining the loss to the individual charge, whereas in the older systems often all the charges on the floor were lost, due to the inability of the workmen to return and attend to the work. The fumes coming regularly from the houses are conducted to absorption systems and recovered.

A charge consists of 1,600 to 1,700 lb. of acid and 32 lb. of dry cotton. The composition of the acids and the temperature of nitration depend on the type of nitrocellulose desired. In general it may be said that nitrogen content increases with increasing total acidity.
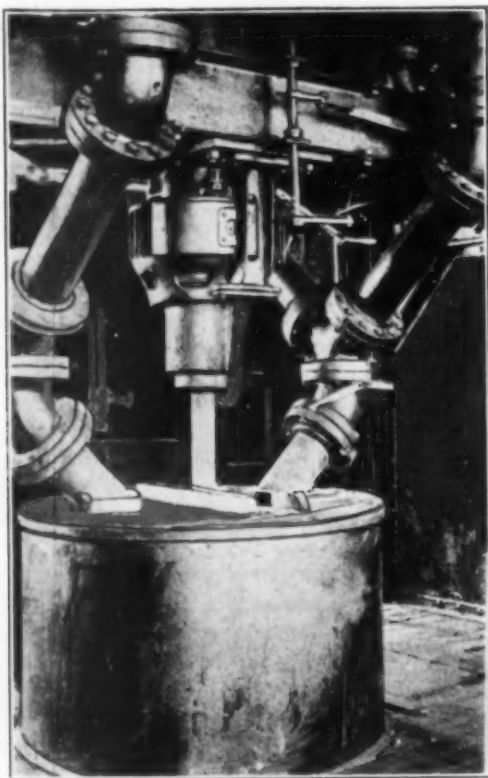

FIG. 3. CENTRIFUGAL SEPARATION OF NITRATING ACID

Increase in ratio of nitric to sulphuric acid, decrease in temperature and increase in time of nitration all increase the viscosity. The influence of nitrosyl-sulphuric acid or of the lower oxides of nitrogen is not thoroughly understood, but undoubtedly, other things being equal, increasing either lowers nitrogen content and viscosity. In addition the nitrosyl-sulphuric acid
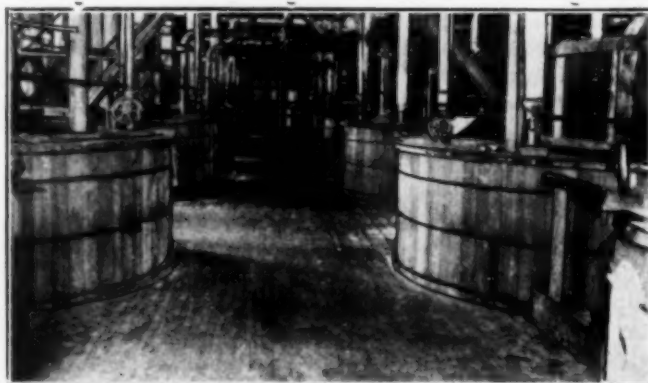
FIG. 4. POACHERS IN WHICH FINAL PURIFICATION TAKES PLACE

has an oxydizing effect on the cellulose, resulting in compounds of low stability, which are destroyed during the purification treatment and hence lower the yield. Moisture in the cotton has a very serious effect on the product in that it dilutes the nitrating acid so that the interior of the fiber is nitrated to a lower degree than the exterior. This gives a non-uniform product, which will show itself in "granularity" or precipitation in the solutions. This, of course, is of less importance where the nitrocellulose is used for its flammable qualities, as in smokeless powder or guncotton, than where it is to be used as a solution, as in the lacquer industry.

BOILING PROCESS TO INCREASE STABILITY

It has previously been mentioned that the early troubles in the development of nitrocellulose were due to improper purification and that Abel introduced pulping to break up the fiber in such a way that the acid retained by capillarity might be completely removed. Even complete removal of acid does not, however, "stabilize" nitrocelluloses. This is due to the fact that the raw material is not pure mature cellulose, but always contains oxy- and hydro-celluloses in addition to less mature or complex cellulose molecules. The nitrates of these bodies as well as the lower nitrates and the sulphates of the pure cellulose which are always formed are unstable bodies. Fortunately they are rather easily broken up by boiling in acid water.

The first step in the purification is therefore prolonged boiling in water containing about 0.1 per cent of sulphuric acid. Extended experiments have shown that more than forty hours' boiling is unnecessary. The prescribed treatment for pyro-nitrocellulose intended for the manufacture of smokeless powder consists therefore of four boiling periods, the first one of sixteen, the other three of eight hours' duration each, with change of water after each boiling. The boiling tubs are generally equipped with a false bottom and a central stack or pipe into which the steam is introduced in order to provide circulation and even heating of the water, somewhat on the principle of the steam injector.

After the completion of the boiling the nitrocellulose is transferred to beaters or Jordans, where it is reduced to a fine pulp. These machines are well known to the paper industry and require no description. From the beaters the pulp is pumped to the poachers, which are simply large wooden tanks equipped with agitators. (See Fig. 4.) Here final purification takes place. As the principal purpose of this purification is the removal of the last traces of acid and the decomposition

products produced in the preliminary boiling, the requirements of the Army and Navy specifications seem somewhat excessive. These call for twelve hours' boiling with five changes of water—i.e., six periods of boiling followed by ten cold-water washings. During this boiling a small quantity of soda may be added. As a matter of fact, millions of pounds of smokeless powders which met all tests have been made from nitrocellulose that had only two periods of boiling (or a total of six hours) and five cold-water washings at this stage of the process.

OTHER METHODS OF PURIFICATION

The purification treatment described applies to nitrocellulose for making smokeless powder. For other purposes this can be much simplified. A great deal of nitrocellulose has been made and no doubt is still made for lacquers and dopes by washing only in warm water and dilute soda solutions. Some boiling should be given, however, but not too much, as excess of boiling has a bad effect on color and clearness of the solutions. Beating may be omitted entirely for this purpose.

Where a particularly white nitrocellulose for colorless or water-white solutions is required, the pulp is given a bleaching treatment with any of the well-known bleaching agents, such as bleaching powder, sodium hypochlorite or permanganate and oxalic acid. It is essential that whatever bleach is used all traces of it must be thoroughly washed out. After the purification treatment the pulp is washed and the water is reduced to about 30 per cent by wringing the pulp in centrifugal machines. Sometimes a wet machine such as is common in the paper industry is used, but this does not reduce the moisture to the same extent.

DEHYDRATION WITH ALCOHOL

In order to remove the last 30 per cent of water, the nitrocellulose was formerly dried by means of hot air. This was a dangerous proceeding, as it was inevitable that dust would accumulate in corners or on steam pipes, where it would gradually decompose and finally take fire, usually causing the loss of the whole house. This drying is now done by means of alcohol, as alcohol is a constituent of most solvents, and where it is not a solvent, the small quantity remaining does no harm. Dehydration by alcohol may be carried on in several ways. The usual method employs a hydraulic press. The equivalent of 50 lb. of dry nitrocellulose, but in the wet condition, is placed in the cylinder of a hydraulic press and compressed to a cake 16 in. in diameter and about 8 in. high, a pressure of about 250 lb. being used. (See Fig. 5.)
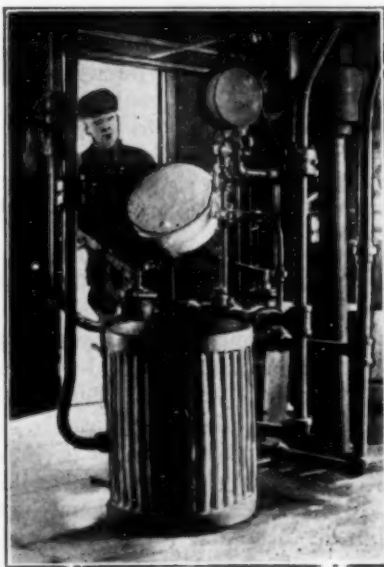
FIG. 5. DEHYDRATING PRESS SHOWING CAKE READY FOR TREATMENT WITH ALCOHOL
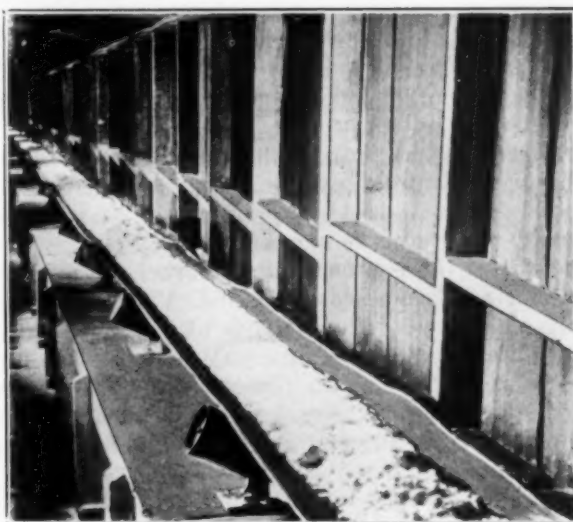
FIG. 6. CONVEYOR CARRYING NITROCELLULOSE TO FINAL PACKING HOUSE

Seventy-five lb. of strong alcohol is then pumped through the cake, being uniformly distributed over it by perforations in the top piston. Actual displacement of the water takes place, as can be shown by taking samples of the discharge. When all this alcohol has been pumped in, the block is saturated with strong alcohol in place of water, and the excess is removed by applying a pressure of 3,500 lb. for a short time. The whole operation with experienced operators takes less than four minutes, and it is therefore the quickest and most efficient method. When the block is removed from the press it contains from 20 to 25 per cent of alcohol, depending on the length of pressing and the character of the nitrocellulose. The block is now broken up in order to make the individual particles more accessible to solvents, and is ready for any of its various uses. Nitrocellulose is not dehydrated for use in gelatine dynamite or charges for torpedoes and mines. In the former case the small percentage of moisture, amounting to perhaps 0.3 per cent of the weight of the dynamite, does not make any difference. In the latter the guncotton is compressed under very high pressure, thus reducing the moisture to about 12 per cent. Guncotton with this percentage of moisture can be detonated by the detonation of a small quantity of dry guncotton.

MILITARY AND PEACE-TIME USES

The uses of nitrocellulose are many and varied. There is probably not a household that does not contain it in one form or another, nor would the World War have been possible on its enormous scale without nitrocellulose powders. As previously mentioned, its first uses were in medicine and in photography, and these uses still continue and have in the latter case reached enormous proportions. Most moving picture and camera films are made from it, and photographic papers receive a preliminary treatment with nitrocellulose solutions. Collodion is still used as the carrier for the sensitive emulsion used in photo-engraving.

During the years of the World War, of course, its largest use was for smokeless powders. Before the war the total capacity of the country for cannon powder was probably not far in excess of 40,000 lb. per day, or 12,000,000 lb. annually. At the time the armistice was signed facilities had been provided to turn out this quantity in less than four days. Most of

the plants that produced this enormous quantity have since been dismantled. Military smokeless powders consist of nitrocellulose alone or of a mixture of nitroglycerine and nitrocellulose. Most countries outside of Great Britain use the former, but even Great Britain was forced to come to it during the war.

One of the largest peace-time uses for nitrocellulose is found in the celluloid or pyroxylin plastic industry. Celluloid, being a trade name protected by registration in the Patent Office, other manufacturers sell this product under such names as Fiberloid, Viscoloid, Pyralin and Herculoid, etc. The methods of manufacture used by the different companies are very similar. The nitrocellulose is prepared with few exceptions, at least in this country, from a pure rag tissue paper. It can, however, be made successfully from cotton. The main consideration is to get a raw material that is clean.

Other important uses are found in the artificial leather and lacquer industries. The first artificial silk was made from nitrocellulose, and fiber silk of this type still holds its own against more recent processes as shown by the construction of a plant for its manufacture in this country within the past year. Nitrocellulose is also used in a variety of other ways such as in solid alcohol, gas mantles, nail polishes and as a coating for gas mantles.

From this brief outline some idea of the importance and magnitude of the nitrocellulose industry and of the interesting problems connected with it should be conveyed. The nitrocellulose industry is based on cellulose, and cellulose itself presents a great many problems. As has been mentioned before, its constitution or chemical structure is still unknown. It has been pointed out elsewhere that original American contributions to cellulose chemistry have been very few. To encourage research and discussion in this field a Cellulose Section has been established by the American Chemical Society. It is hoped that all who are interested in this subject will enroll in this section and take part in future meetings, which should prove profitable and interesting.

Lead and Zinc Pigments Marketed in the United States, 1919-20

The following table shows the amount of lead and zinc pigments marketed in the United States in 1920, with the value and average selling price of each, compiled from reports made by producers to the United States Geological Survey, Department of the Interior. Figures for 1919 are also shown for comparison.

An increase in the quantity sold was shown by every product except zinc oxide, in which there was a loss of 15 per cent, but the average price per ton of zinc oxide showed a slight gain. There was also an increase in the average selling price of the other pigments. The greatest gains in 1920 were made by litharge, in which the gain in sales was 33 per cent and the gain in average price per ton was $61.11, or 44 per cent.

LEAD AND ZINC PIGMENTS MARKETED IN THE
UNITED STATES, 1919-20

	1919			1920		
	Quantity, (Short Tons)	Value Total	Per Ton	Quantity, (Short Tons)	Value Total	Per Ton
White lead:						
Dry	30,085	$4,845,788	$161.07	33,678	$6,351,798	$188.60
In oil	109,005	21,579,234	197.97	112,017	25,986,100	231.98
Red lead and orange mineral	32,362	5,314,255	164.21	34,431	7,523,089	218.50
Litharge	46,739	6,431,801	137.61	62,329	12,386,185	198.72
Zinc oxide	117,639	20,591,877	175.04	99,444	17,859,736	179.60
Leaded zinc oxide	27,591	4,009,024	145.30	30,460	4,467,532	146.67

Chemical Dips Prevent Blue Stain in Lumber*

Blue stain is the most troublesome of the sap stains which discolor wood. It is caused by a fungus which germinates on the sapwood and penetrates its cells in search of starches and sugars. This action of the fungus causes no perceptible weakening of the wood, but the discoloration which results lessens the value of the lumber for many purposes, such as interior finish, flooring and basket and box veneers. The stain at first may be no more than a bluish spot or stream on the surface, but later, as the fungus develops, the discoloration may involve all of the sapwood and become too deep to surface off. The blue-stain fungus can revive in timbers after long periods of inaction brought on by lack of moisture.

GREEN LUMBER MOST AFFECTED

Warm weather and a comparatively high moisture content of the wood are the most favorable conditions for the growth of the blue-stain fungus. Most of the infection occurs in green lumber which is piled without ample ventilation between the boards in the mill yard or during shipment.

As yet no absolutely dependable means of preventing blue stain has been found, other than kiln drying the lumber. The ordinary kiln-drying process is entirely effective against blue stain, but there are many cases in which this means of prevention is not feasible. Staining during air seasoning can be largely controlled by open piling. This affords free circulation of the air and so hastens drying, but not always sufficiently under adverse weather conditions to discourage the stain fungi.

CHEMICALS USED TO PREVENT STAIN

The treatment of the green lumber with antiseptic dips is the most effective method which is generally applicable at the present time. For this purpose the chemicals commonly used are sodium carbonate and sodium bicarbonate. Neither is a sovereign remedy under severe conditions, such as continuous rainy periods during the warm months, but will go far towards keeping the stock clean. In rainy seasons an 8 per cent solution of sodium carbonate is desirable, but in drier weather half this strength should suffice. A high grade of soda ash should contain about 58.5 per cent alkali, and every effort should be made to conform to this standard of purity. When sodium bicarbonate is used, an 11 per cent solution should be employed in wet weather and 5 to 6 per cent in dry weather. This chemical when dry should contain about 37 per cent alkali.

POINTS TO BEAR IN MIND

In the use of these chemical dips, the following points should be kept in mind: The solutions should be carefully mixed and the concentrations in the dipping tanks should be kept uniform by means of a hydrometer; the solutions should be heated when applied, the bicarbonate solution not above 120 deg. F., however, because it is broken into the carbonate by excessive heating; the stock should be dipped as it comes from the saw; after dipping it should be carefully piled so as to insure ample ventilation. Narrow, chemically treated cross strips are preferable to the wide untreated strips commonly employed, since treated crossers tend to eliminate stain at the point of contact.

*From U. S. Forest Products Laboratory *Technical Notes.*

Some Points in the Design of Blast-Furnace Gas Cleaners*

Methods for Determining the Velocity and Moisture Content of Hot Gases Flowing Through Large Pipes —Calculations for a Heat Interchanger Built to Cool Gas From a Ferromanganese Furnace at 1,200 Deg. F. to 400 Deg. F. Without Increasing Its Absolute Humidity

By N. H. GELLERT
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THE problem of cleaning gases issuing from a blast furnace has never been a simple one. Various methods of cleaning gases have been discussed so thoroughly in papers which have been read in the past before technical societies interested in this general subject that there is no need of reviewing this subject again at this time.

It is of course essential in the very beginning to know the condition of the blast-furnace gas before there can be any intelligent attempt to clean the dust and fume from the gas. In general, blast-furnace gases contain from 2 to 10 grains of dust per cu.ft. of gas at standard conditions of temperature and pressure—namely, 62 deg. F. and 29.92 in. Hg. This dust exists in the form of both dust and fume. The fume is so finely subdivided, however, that in a great many respects it acts as a perfect gas.

In order to determine how to apply a cleaner to the blast-furnace gas, there are at least four things which must be investigated: Velocity and volume, dust content, moisture content and temperature.

The equipment necessary to make a volume determination, as a rule, is a Pitot tube of a standard type, a manometer tube, rubber tubing, some boards and nails, measuring rule and a few tools. A gas-measuring station location should be selected in the gas main where the most uniform gas flow conditions are approximated. The conditions are always adversely affected by bends, connections, off-takes, explosion doors, manholes, etc. If a straight portion of main can be found four to ten times the diameter in length and without valves, off-takes or some other interfering object, the conditions may be assumed to be good for gas measurements.

After this station has been located, it is necessary to determine the inside dimensions of the main in which the flow of gas is to be measured. If the main is horizontal, care should be used in sounding the inside bottom of the main for any deposits of flue dust which may reduce the total cross-sectional area. The area of

TABLE I. DIAMETER AND RADII OF CONCENTRIC RINGS FOR TEN EQUAL AREAS

Area	Diameter of Outer Edge of Ring	Mean Velocity Point — Distance From Center	Distance From Sides of Pipe
1	31.6	11.2	38.8 and 61.2
2	44.7	19.4	30.6 and 69.4
3	54.7	25.0	25.0 and 75.0
4	63.2	29.6	20.4 and 79.6
5	70.7	33.5	16.5 and 83.5
6	77.5	37.1	12.9 and 87.1
7	83.7	40.3	9.7 and 90.3
8	89.4	43.3	6.7 and 93.3
9	94.9	46.1	3.9 and 96.1
10	100.0	48.7	1.3 and 98.7

the circular main should then be calculated. The velocity of the gas flowing through the main is greater at the center than near the walls. Therefore to get the average gas velocity it is necessary to take a large number of velocity readings across one or preferably two diameters of the main. By dividing the main into equal areas as in Tables I and II it is possible to get the average main velocity in the simplest way and with the least expenditure of time. The average velocity of the total gas flow will be the average of the velocities at the mean velocity points of the equal area zones.

TABLE II. DIAMETER AND RADII OF CONCENTRIC RINGS FOR FIVE EQUAL AREAS

Area	Diameter of Outer Edge of Ring	Mean Velocity Point — Distance From Center	Distance From Sides of Pipe
1	44.7	15.8	34.2 and 65.8
2	63.2	27.4	22.6 and 77.4
3	77.5	35.4	14.7 and 85.3
4	89.4	41.8	8.2 and 91.8
5	100.0	47.4	2.6 and 97.4

Under normal conditions the following formula applies to blast-furnace gases.

$$V = 2.9\sqrt{TH}$$

Where

V is the gas velocity in ft. per sec.;

T is temperature in deg. F. plus 460, and

H is velocity head in inches of water.

There have been two methods developed for determining the vapor volume and the resulting volume of the gas mixture. Both methods check within 10 per cent for moisture and within less than 1 per cent for totals of gas and moisture. The formula resulting from one of these methods is:

$$Vf = Vw \times \frac{Vs}{Ts} \times Tf + Vm \times \frac{Tf}{Tm} \times \frac{Pm}{Pf}$$

Where

Vf is volume of gas at conditions in main in cu.ft.;

Vw is volume of vapor at main conditions in cu.ft.;

Vm is volume of dry gas at meter conditions in cu.ft.;

Tf is absolute temperature at main conditions;

Tm is absolute temperature of gas at meter;

Ts is absolute temperature of the saturated vapor or steam at the pressure of gas main;

Pm is absolute pressure of meter in inches of mercury. It equals $B - Pm$ if pressure is negative (B is 29.92 in. Hg when standard);

Pf is absolute pressure of gas main or flue. It equals $B + Pf \times 0.0735$ if pressure is positive;

Pf is absolute pressure in inches of water in flue or main;

Vg is the vol. of dry gas at main conditions in cu.ft.;

Vs is specific volume of unit mass of water as saturated vapor at pressure of main.

TABLE III. VALUES OF $\frac{V_s}{T_s}$ FOR 1,000 g. SATURATED STEAM AT VARIOUS PRESSURES EXPRESSED IN POUNDS, ABSOLUTE

Absolute Pressure, Lb.Sq.In.	Saturation Temp., Deg. F.	$\frac{V_s}{T_s}$	Absolute Pressure, Lb.Sq.In.	Saturation Temp., Deg. F.	$\frac{V_s}{T_s}$
10	193.2	0.1300	23	235.5	0.0560
11	197.8	0.1179	24	237.8	0.0533
12	202.0	0.1081	25	240.1	0.0515
13	205.9	0.0995	26	242.2	0.0495
14	209.6	0.0925	27	244.4	0.0476
15	213.0	0.0863	28	246.4	0.0458
16	216.3	0.08075	29	248.4	0.0442
17	219.4	0.0760	30	250.4	0.0427
18	222.4	0.0718	31	252.3	0.0413
19	225.2	0.0680	32	254.1	0.0400
20	228.0	0.06435	33	255.8	0.0388
21	230.6	0.0613	34	257.6	0.0377
22	233.1	0.05845	35	259.3	0.0365

TABLE IV. VALUES OF $\frac{V_s}{T_s}$ FOR 1,000 g. SATURATED STEAM AT VARIOUS PRESSURES EXPRESSED IN INCHES OF WATER*

Pressure in In. Water, Below 1 Atm.	Saturation Temp.	$\frac{V_s}{T_s}$	Pressure in In. Water Above 1 Atm.	Saturation Temp.	$\frac{V_s}{T_s}$
20	209.5	0.093	20	214.2	0.0840
18	209.8	0.0925	18	214.0	0.0844
16	210.0	0.0920	16	213.8	0.0846
14	210.2	0.0915	14	213.5	0.0851
12	210.5	0.0909	12	213.3	0.0855
10	210.8	0.0904	10	213.0	0.0860
8	211.0	0.0899	8	212.8	0.0864
6	211.2	0.0894	6	212.6	0.0868
4	211.5	0.0889	4	212.4	0.0873
2	211.7	0.0885	2	212.2	0.0877
0 or 1 atm.	212.0	0.0881	0 or 1 atm.	212.0	......

* One atmosphere equals 14.7 lb. per sq.in., 29.92 in. Hg, 33.93 ft. of water at 60 deg., or 407.16 in. of water at 60 deg. One inch of water equals 0.0735 in. of mercury.

In Europe the practice has been somewhat different from that in the United States, as there were early efforts to develop dry cleaners. As a matter of fact, dry cleaners have been operating in Europe for some time and have been mainly objectionable for two reasons: High cost and possible damage to the cleaner.

The cleaners built in Europe were of the bag type and while they cleaned the gas more effectively than any primary cleaner could and even went so far as to prepare the gases for gas engine purposes, the bags, being of a flammable nature, necessarily were subject to destruction whenever the heats put through the cleaners exceeded the safe limits of the material of which the bags were made. The high cost also of installation of this type of cleaners militated very greatly against their adoption and perhaps was the chief reason why such dry cleaners were not installed in this country.

Perhaps a third feature which militated against the use of these dry cleaners was the fact that the sensible heat lost in the cooling of the gas robbed the gas of a great deal of the economies which might be obtained were the sensible heat retained.

Any screen type of cleaner which attempts to filter out particles of dust and fume, even when the filtering medium is not destroyed by the normal heats of the blast-furnace gas, must be sufficiently fine in nature to present a hole smaller than the finest particle of dust and fume going through in order to remove successfully the objectionable solid material in the gas. If the screen is so fine that it will remove the particles of fume, the back pressure will be high and the screen will clog up quickly. If the screen is designed with apertures large enough to prevent any considerable back pressure, the fine particles of fume and dust will go through. The problem, therefore, of screening the fume and dust out of the blast-furnace gas is not a simple one.

It is very evident on further thought that conditions arise when the gas discharging from the furnace top is very hot and it is impossible to utilize any system of dry cleaning without destroying the cleaning medium. For instance, in the manufacture of ferromanganese, the gases discharging from the furnaces have temperatures running as high as 1,500 deg. F. As steel glows red hot at temperatures of this kind, some necessity arises for cooling the gas to such a point that destruction of the steel does not take place. If it is desirable to cool the gas which is as high as 1,300 deg. F. to a temperature between 400 and 500 deg. so as not to lose the sensible heat which is present in the gas at this lower temperature, care must be taken not to add water for cooling purposes, as the amount of water present when the gas is saturated at 400 deg. F. is so great that it would seriously handicap combustion in the stoves and boilers. A cooler therefore must be of such a type that the heat is transferred from the gas into the water through tubes and not by direct contact.

In actually designing one of these coolers for a ferro-manganese furnace the following formulas were used; and it was possible to check the design of this cooler after it went into operation. The results obtained are within 85 per cent of the calculated figures.

$$Sh = \text{specific heat of gas;}$$
$$Gw = \text{wt. of gas per hr.;}$$
$$Gt_1 = \text{temp. of inlet gas;}$$
$$Gt_2 = \text{temp. of outlet gas;}$$
$$Wt_1 = \text{temp. of inlet water;}$$
$$Wt_2 = \text{temp. of outlet water;}$$
$$C = \text{constant (5);}$$
$$A = \text{condensing area in sq.ft.}$$

$$A = \frac{Gw \times Sh(Gt_1 - Gt_2)}{[\frac{1}{2}(Gt_1 + Gt_2) - \frac{1}{2}(Wt_1 + Wt_2)] \times C}$$

$$Wt_2 = \frac{Sh \times Ws}{W} \times (Gt_1 - Gt_2) + Wt_1$$

$$\frac{W}{K} = 5 \qquad K = Gw.$$

A typical example of calculation per 200 tons pig iron per twenty-four hours is as follows:

```
200 tons coke per day = 400,000 lb. coke per day
65 cu.ft. gas per lb.
26,000,000 cu.ft. gas per day
1,080,000 cu.ft. gas per hr.
18,000 cu.ft. gas per min.
1,080,000 cu.ft. gas per hr.
Wt. per cu.ft. blast-furnace gas = 0.081 lb.
Spec. heat blast-furnace gas = 0.24
Temp. inlet water = 60 deg. F.
Temp. outlet water = 150 deg. F.
Temp. inlet gas = 1,200 deg. F.
Temp. outlet gas = 400 deg. F.
1,080,000 × 0.081 = 88,000 lb. gas per hr.
```

$$A = \frac{88,000 \times 0.24 \times (1200 - 400)}{[\frac{1}{2}(1200 + 400) - \frac{1}{2}(60 + 150)] \times 5}$$
$$A = \frac{21,100 \times 800}{(800 - 105) \times 5} = \frac{16\,880\,000}{695 \times 5}$$
$$A = 4,850 \text{ sq.ft.}$$

1 length 4-in. pipe 30 ft. long has area of 30.14 sq.ft.
4850 ÷ 30.14 = 161 lengths.

Check:

5 B.t.u.'s transmitted per sq.ft. per hr. per deg. difference in temperature.

Then:

4,850 sq.ft. is area.

$$\frac{(1,200 + 400) - (150 + 60)}{2} = 695 \text{ deg. F.} = \text{difference in temperature.}$$

Then:

B.t.u.'s transmitted per hr. = 4,850 × 695 × 5 = 16,900,000
Now gas given up is 88,000 lb. gas per hr.
Specific heat = 0.24
Difference in temperature, 800
Then B.t.u.'s given up by gas per hr. = 88,000 × 0.24 × 800 = 16,850,000 B.t.u.'s

Water used:

Difference in temp. 90 deg. F.
B.t.u.'s absorbed, 16,900,000 per hr.

$$\frac{16,900,000}{90} = 187,000 \text{ lb. per hr.} = 22,600 \text{ gal. per hr.} = 376.6 \text{ gal. per min.}$$

Chemical Stoneware Manufacture

Production of Chemical Stoneware Involves Ceramic Problems Different From Other Wares for Varying Uses in Chemical Plants—Preparing the Body—Aging the Clay—Fabricating the Pieces —Drying and Burning—Finishing the Burned Ware—Plant Control

By CHESTER H. JONES

POTTERY bodies, common brick, terra cotta, etc., may be likened to cast iron in general qualities of strength and methods of working the raw materials, common stoneware may be compared to malleable iron in physical properties, but chemical stoneware is the *steel* of the ceramic industry. The clay is first weathered, treated and aged, then worked, rolled, pugged and beaten until the resultant product can be handled almost like slabs of leather; it is erected section by section into the shape desired; the piece is tempered in the drying, with time an important factor after the manner of steel, and then it is soaked in the heat of the kiln up to 2,700 deg. F. until complete vitrification is attained throughout the entire body. Thus the finished piece can resist maximum mechanical shocks, temperature changes and acid attack. It may be hammered vigorously without breaking.

As a testimonial to the resistance to temperature variations the first thing that strikes the eye of the visitor at the plant of Maurice A. Knight, at Akron, Ohio, is the apparatus appearing on one of the stacks shown in Fig. 1. Several years ago two 50-gal. acid receivers and two 1½-gal. monkey pumps were mounted in this position. They are subjected to flame from the stack on one side and cold wind and sleet on the other throughout the winter months, yet no deterioration is apparent.

For acid-resistant qualities in general two different bodies are manufactured. One, where hot concentrated fumes like hydrochloric and nitric acids with little condensation must be retained, requires a more porous body to resist expansion and contraction; the other, where corrosive liquids or condensation products are in contact, demands a denser body to obviate possible seepage.

RAW MATERIALS

The clays used in manufacturing chemical stoneware must have high bonding strength, small drying and burning shrinkages and a rather wide range of vitrification. Crushed stoneware scrap is often added as grog to reduce the shrinkage. The Bureau of Mines has issued a valuable bulletin (Technical Paper 233, "The Properties of Some Stoneware Clays," by H. G. Schurecht) describing various tests and properties of these clays as found in the Ohio and Pennsylvania fields.

In general there are seven different clays used at the Maurice A. Knight plant, so blended as to produce as many different stoneware bodies. The manufacture of the different wares requires the study of the chemical engineer co-operating with the ceramist in order that the mix of clays for the body may be varied to meet the conditions of different applications in any acid system. Two clays may have approximately the same chemical composition but vary in grain size. Tougher bodies are produced by mixing them to get a varying size of silica grain. The chief constituents are alumina, silica and some magnesia with minimum content of iron, lime and alkali salts. Fineness of grain is the most essential physical feature. All clays are carefully analyzed in both the chemical and ceramic laboratories.

The clays arrive by rail, coming principally from the Ohio, Tennessee and New Jersey fields. Some English clays are also used. They vary from plastic ball clay to high-grade plastic fireclay. The raw material is weathered in stock piles for periods ranging from one to six months. The superintendent in charge of purchasing inspects all clay as it is mined, watching the strata closely to be sure the raw product of the pit is uniform.

Dry grinding is employed at this plant in preparing the clay. The whole operation is carried on without the use of blungers or filter presses. A better body for chemical stoneware is obtained by this method, because a considerable amount of salts ordinarily washed out by the blunging and filtering method are retained
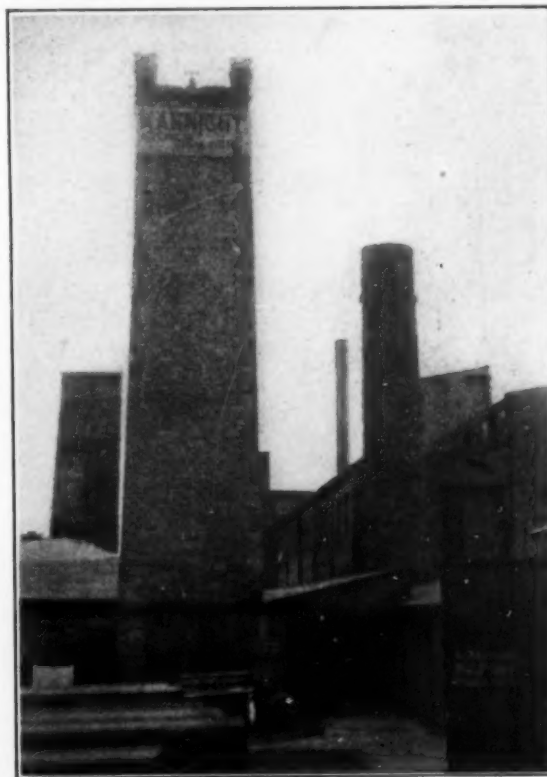

FIG. 1. TWO 50-GAL. ACID RECEIVERS AND TWO 1½-GAL. MONKEY PUMPS (ON TOP OF STACK)

to give added toughness and strength as well as longer life to the burned piece. Not only is the clay more easily cut and worked in the plastic stage, but during the firing these ingredients assist in distributing the vitrification through the body to produce a tougher ware.

The ware is often rougher in appearance than is that made by the wet process, but actual breaking tests have shown the burned piece to have greater strength. Toughness and thorough vitrification of body to resist corrosive action are, of course, first requisites of chemical plant apparatus.

The clay mix first enters the two dry pans, one of which is shown in Fig. 2, where it undergoes a long period of grinding. Grog or broken stoneware is ground with the clay for some of the bodies. When the material has reached sufficient fineness it is drawn off to an inclined floor, at the bottom of which are three chaser mills. The fine clay is introduced to these mills, where a certain amount of water is added—just enough to secure a workable product. Grog is used only in batches for making larger ware.

From two and one-half to four hours is required for this operation. The chaser mill resembles the dry pan in general appearance except that the wheels have only

FIG. 2. DRY PANS

a 3-in. face and the pan remains stationary while the horizontal axle carrying the wheels is revolved about a vertical central shaft. At the same time this axle is being turned on a pivot normal to its axis the wheels sliding upon it are "chased" back and forth from the center to the outer edge of the pan, thus grinding the wet clay over all parts of the bottom.

The chaser is an old piece of equipment in the clay industry and has been largely superseded by the wet pan and other processes. Its output is limited both because of size of batch and because of speed of operation. The quality of product turned out is of the finest

and toughest texture, mainly because the method tempers as well as grinds the clay.

When each chaser batch is finished as determined by an operator who becomes expert on the "feel" as well as the formula, it is transferred to the concrete aging pits, where it remains for varying periods, the longest being about six months. During this time it is covered with sacking or burlap, which is moistened each day.
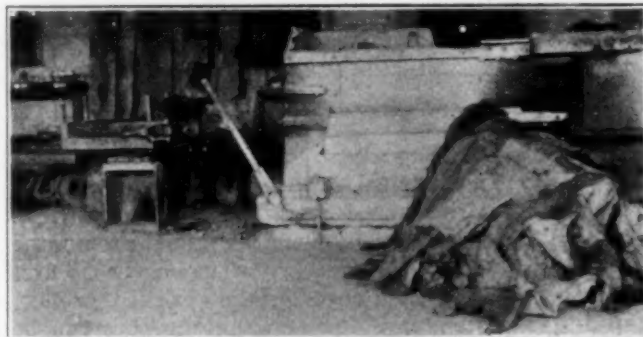
FIG. 3. AUGER MACHINE

The practical effect of aging this clay is to increase its plasticity and toughness. It has a "rubbery" appearance and feel.

Recent research into the reason for aging clay and the phenomena involved has indicated that during the aging period there is a growth of green filamentous algæ as examined under the microscope. This growing is accompanied by the evolution of CO and CO_2. The next point is to determine why the presence of this algal growth increases the plasticity, and the work of H. Spurrier and others will be awaited with interest.[1]

When the clay is removed from the aging pits the edges and surfaces are trimmed off. These trimmings, together with clay trimmings from subsequent forming processes are used in making chemical brick. Thus only the very tough dense product from the inner part of each pile is used in forming other chemical ware. Two-ton Bonnot repress brick machines with others are located on the same floor as the aging pits. The clay for various shapes and vessels is transported on shelf elevators to the upper floors, where it enters the structural departments.

Next in importance to the scientific selection of raw materials and careful preparation of the plastic, tough clay under technical control come the design and erection of the piece to give the best service in the chemical plant. This is truly a function of chemical engineering —namely, to evolve the most suitable mechanical device that will best handle the certain phase of the chemical process. The potter is guided by the engineer to devote his skill and training to chemical plant design.

The technique of stoneware manufacture requires considerable mechanical care. Shrinkage in drying and burning must be taken into consideration in the original dimensions of the wet piece. This varies from 8 to 12 per cent of the volume, with an average of 10 per cent, in the drying and firing shrinkage. Accuracy of measurement is very necessary since many of the parts must fit together when erected in place.

The section devoted to the manufacture of stoneware pipe employs a J. D. Fate auger machine shown in Fig. 3. The sacking in the right foreground covers the operating stock of clay to prevent surface drying.

[1] "The 'Why' of Aging Clay," *J. Am. Cer. Soc.,* vol. 4, No. 2.

FIG. 4. MANIFOLD FOR NITRIC ACID

All working piles, as well as newly formed ware about the plant, are kept thus protected. In the case of the latter protection is necessary to prevent too rapid drying and surface cracking.

The clay is thrown into the chamber of this machine and pipe is extruded through suitable dies on the left end, the clay being forced out by a slowly revolving screw. This method produces pipes free from laminations, such as may occur in sewer pipe presses. Fig. 4 shows some special nitric acid manifolds. The main length is formed in the auger machine, while the branches are made by hand and on the potter's wheel or jigger. Other small pieces are turned on ordinary machine lathes. The whole is assembled by careful hand work. Chamotte pipes do not require a tight vitreous body, because they convey only hot gases with no condensation. Fireclay would disintegrate if used for this purpose. This open, porous body is of course not used where much liquid is present.

Another machine used in making pipe sections is the sewer pipe press operated by steam pressure. It will produce pieces from 2 in. to 36 in. in diameter, but is used only for the smaller bores, where the possibility of laminations is minimized. The converging pressure during the molding of the smaller diameter pieces works the clay to prevent such laminations. Larger bore pipe such as tower sections are all hand built the same as receivers and jars.

Large pieces of chemical stoneware are made entirely by hand. Plaster of paris molds are first built in take-down sections. One of these assembled molds appears on the extreme left of Fig. 5. The pieces in the foreground are finished filter bottoms resting in the bottom mold with the side sections of the mold removed.

The clay for this construction is batted and rolled out into sheets near the required thickness and of such dimensions as the modeler can pick up from the table and transfer to the mold. These sheets are easily handled, being quite tough and flexible. The modeler

FIG. 5. FINISHED FILTER BOTTOMS

slaps them into the mold and proceeds to work them into place, taking special care to see that the line of juncture with adjacent pieces is entirely eliminated by working the plastic material to a firm weld. A joint thus made is said to be stronger and less apt to break than other parts of the piece. The whole operation reminds the spectator of movements carried on in the welding of steel tanks.

When the work is complete and the clay has become one piece, the sides of the mold are immediately removed, the bottom of the mold being left for a support until the air drying is completed. Wet cloths are thrown over the top, as seen in the left of Fig. 6, to prevent premature drying. Finally these are removed, as seen on the right in the same picture, and the heaviest piece may be lifted by the rim in transferring to the driers—a fact which roughly demonstrates the bonding strength of the clay.

Further question of shape may be noted in these large pieces. Examination of the foremost piece in Fig. 5 will show that the vertical outline is not straight, but curves outward toward the bottom. This is necessary, because the moisture aided by capillary action settles to the bottom during drying and would warp the piece unless provided for in the first place. This ware

FIG. 6. LARGE PIECES OF CHEMICAL STONEWARE

when burned will have the perfectly straight edge as intended by the designer. Like irregularities must be worked in throughout the fabrication of all sorts of shapes. In the tank department units up to 500-gal. capacity can be made, but it is recommended that sizes be limited in general to 200-gal. capacity so that in case of accidental breakage less solution will be lost.

One of the large-quantity products of the Knight company is the etching machine which is sold to engravers, photographers and printing establishments. Several of these are shown ready for the drying room in Fig. 7. The four holes in the side of the box permit the introduction of four revolving paddle wheels, one of which is seen lying across the top of the box, with others drying on the floor in the immediate foreground. The piece of clay pipe lying across the top of each box is a temporary support to hold the walls in place during drying and burning.

Thin sections of dense clay are required in the manufacture of this ware and other containers and condensers for hydrochloric and nitric acids. Here the temperature changes are not great, but liquid must not seep through the pores. Battery jars and electrolytic cells likewise require a dense body, but the sides are built heavier to support the electrodes. The pieces shown in Fig. 8 are parts for the electrolytic cell units in the process of air drying.
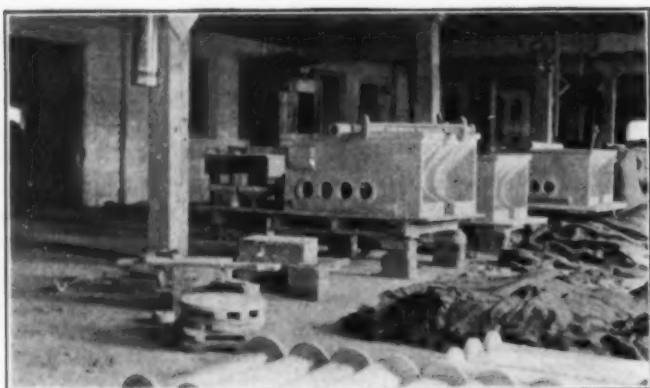
FIG. 7. ETCHING MACHINES

The finished piece shown in the foreground of Fig. 9 is a 2-in. bore 100 ft. condenser coil for nitric acid, one which always attracts attention to the apparent intricacy of the modeler's work. Its manufacture is, however, quite simple. The support is first built up and then the necessary length of pipe is taken moist as it comes from the auger machine and wound into place by hand, care being taken to allow for necessary shrinkage in drying and burning. A piece of asbestos sheet is inserted between each lug and the section of pipe which rests upon it. This prevents the pipe from burning to the lug in the kiln and permits the entire coil in contracting to slip over the lugs. When the piece is finished, the coil may contract and expand independently of the movement of the supports. The asbestos pieces are changed to a ceramic material by
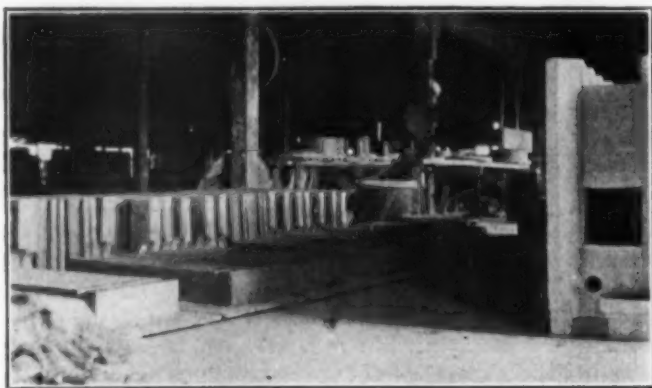
FIG. 8. PARTS FOR ELECTROLYTIC CELLS IN PROCESS OF DRYING

the heat and resemble burned clay. They remain in place to give an even support to the coil.

The development has just been completed of a porous chemical stoneware acid carboy stopper. It is shaped like a button head rivet with slightly tapered shank and with crossed groove in the head to receive the wires for binding over the mouth of the carboy. The smooth surface on the under side of the head fits against the rim of the mouth and a rubber or asbestos washer is inserted between.

The clay body is burned porous so that gas will leak through to the outer air but so that liquid will not permeate the pores to any extent. The release of gas prevents the blowing out of stoppers. The importance of this feature is readily recognized by shippers of concentrated nitric acid, who are familiar with fires started in cars and warehouses during warm weather

by the carboys breaking and acid igniting the packing and crating. These stoppers are made on a press which machines the shank and under portion of the head and molds the head in the same operation. It is manufactured by the Baird Machine & Manufacturing Co. of Detroit and produces fifteen stoppers per minute.

Stoneware cocks and faucets are made from clay stock specially selected from the center of the aging pits. The shapes are worked up in the jigger, a potter's wheel with mold top, and are worked by hand to give the desired key or bowl. The key and bowl of such faucet travel as mates through the entire process. They are identified by numbers stamped in the plastic clay, which differs from common practice of stamping a lead plug inserted after burning.

In making faucets, pipe, etc., the threads are cut in
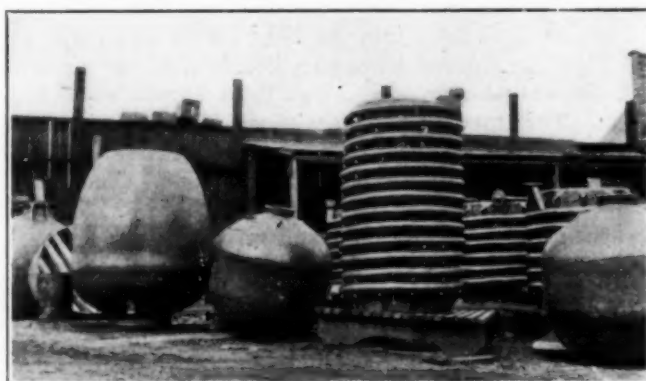
FIG. 9. CONDENSER COILS FOR NITRIC ACID

the wet clay on a machine tool lathe, which insures clean, fine threads after the ware is burned. Comparison with molded threads at once shows the value of this operation. The lathe used is a standard metal-cutting machine made by the Strong, Carlisle & Hammond Co.

After the two parts of a faucet have been through the kiln, the key is mounted, tapered end up, in a jigger and revolved while the operator holding the bowl grinds it to a perfect fit. Wet carborundum dust is applied as the only abrasive which will cut the vitrified material. Fig. 10 shows faucet parts in the grinding room. In the manufacture of stoneware pumps the piston is ground to the cylinder in exactly the same manner. Perfect hollow spheres used for valves in automatic acid lifts are produced by grinding. Nitrating kettles and autoclaves with stirrers having fitted stuffing boxes all made of stoneware may be operated under gas pressure of 40 lb. and upward. All such parts may be lubricated with ordinary oils or greases.

FIG. 10. FAUCET PARTS IN THE GRINDING ROOM
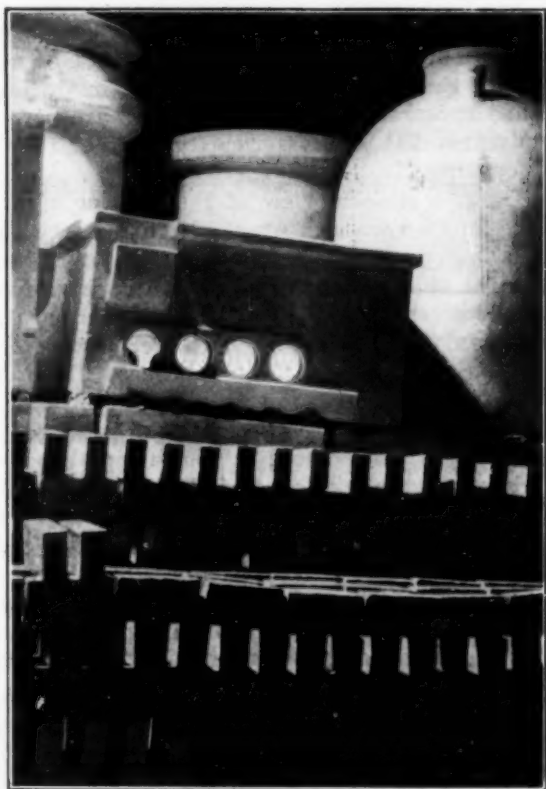
FIG. 11. METHODS OF LOADING WARE
IN THE KILN

With the clay worked to so many shapes and sections
in the same piece, the process of proper drying becomes
most important. As previously mentioned, all possible
skill is used in the fabrication to preserve the body
from warping with the 10 per cent shrinkage occurring
in drying and firing. The removal of moisture must be
very slow at first to prevent surface cracking and pro-
duce tough body.

The finished pieces are first allowed to set in the air
of the molding rooms under wet sacking covers as men-
tioned and shown in the preceding photographs. The
period in the room air drying just before the clay
becomes set is the critical point where the wet sack
covering is most important.

The actual structure of a mass of clay to be dried
is made up of grains of material, each grain being
surrounded by a pool of water, which gives cohesion to
retain the shape. During the drying process the capil-
laries in the mass become smaller. The water on the
exposed surface evaporates and the water inside flows
to the surface through the capillaries. Shrinkage is
caused by the removal of these pools of water and by
the particles coming in closer contact. Aside from the
capillaries, there are still pores between the particles.

In this first part of the drying process carried on in
the air of the room for periods varying from one to
eight weeks the shrinkage is proportional to the water
removed due to this contraction of capillaries. The
subsequent removal of the water in the hot driers is
not accompanied by much shrinkage. In surface evapo-
ration the safe rate of drying must not be greater than
the rate at which the water comes from the inside of
the mass through the capillaries; otherwise surface
strains are set up, causing cracks, because the plastic
interior is non-compressible.

After the ware has undergone the initial set, it is
removed to the hot drier, which consists essentially of

a large room with shelves located over a grated wooden
floor beneath which steam pipes are laid. Here it is
allowed to remain from three days to two weeks—that
is, until all but the hygroscopic water is driven off,
leaving the ware ready for the kiln.

The burning equipment of this plant consists of six
30-ft. periodic down-draft kilns, each one connected
with individual flue of a double stack. High-grade
Pittsburgh coal is employed for fuel.

Fig. 11 shows ware stacked in the kiln ready for
burning. Chemical brick or tile is piled up from the
floor for a height of about 3 ft. to form a checkerwork
for an equal distribution of the draft over the whole
kiln. This also lifts the finer structure pieces to the
best heat zone of the kiln. Chemical brick is then a
sort of byproduct of the molded ware, not only because
the trimmings of the aging pit and modeling room are
used as raw material but also in regard to this need of
a distribution bottom in the kiln setting. The resulting
brick are therefore made from much better material
and burned more cheaply than could be accomplished
in the case of manufacturing the one product.

No cones are used in recording the temperatures
during burning. An indicating Price temperature re-
corder is located in the foreman's office, and a recording
instrument of the same type is placed in the general
manager's office, as shown in Fig. 12. The multiple
switch in the upper left hand corner is used for switch-
ing the instrument to connect with any kiln. The
recorder marks the sheet by perforating at intervals
with an electric spark. The electricity is furnished
from dry cells contained in the case to the right of the
instrument.

The burning time varies from five to eight days,
depending on the size and thickness of the ware. The
first operation, which consists of water smoking, is car-
ried on for two or three days at a temperature up to

FIG. 12. KILN TEMPERATURE RECORDS

FIG. 13. CLOSE-UP VIEWS OF FINISHED WARE
IN THE KILN

300 deg. F. While the material from the hot driers is apparently dry, it still contains a large quantity of hygroscopic water as well as the water chemically combined with the clay. During this period a large amount of white steam issues from the stack. The driving off must be carried on slowly or the water will be too quickly converted to steam and the clay body be damaged. This is particularly true in the case of dense stoneware clays where the pores are exceedingly small, permitting only a slow passage of water vapor from the interior of the body.

When this period is completed as determined by moisture tests of the stack gases, the drafts are opened and the firing increased up to 1,000 deg. F. This step is to drive off the water of crystallization or chemical combination, which occurs quite rapidly at this temperature. The temperature rises quite slowly at this time, however, because a large quantity of the heat is absorbed in breaking off the water. At the same time any carbonates present are broken up to form oxides and CO_2, which absorbs additional heat. The end of this operation may be determined by weighing the test-pieces until loss of weight is no longer evident.

During the latter part of this period the oxidation of any materials like ferrous oxide, carbon, sulphur, etc., that may be present takes place. Since chemical stoneware clays are selected nearly free from such elements, the vitrification stage is almost immediately entered upon. It requires about two days' time to raise from the water smoking stage, about 300 deg. F., to the vitrification or maximum temperature, 2,600 to 2,700 deg. F. Vitrification really begins at the lower temperature, but does not become apparent to the observer until the higher temperatures are reached. The high soaking temperature runs about twenty-four hours from 2,000 deg. F. up to the maximum, 2,700 deg. F.

It is here that the size of grain of the different clays, as mentioned at the beginning of this article, exerts the most profound influence in governing the kind and amount of body fluxing. The fineness of grain insures more ready assimilation of every particle to form a homogeneous body completely vitrified throughout. It makes for a tough, strong body impervious to corrosive attacks in the finished piece. True in case of the heavy, thick sectioned pieces where grog is used to give firm skeleton to hold this mass to shape when in the hot colloidal condition, the bits of grog do not melt down. It will be recalled, however, that this grog was ground from previously burned stoneware in the first place and is therefore tough and impervious to acid.

During the high soaking period a few pounds of com-

mon salt is thrown into each firebox to give a glaze to the ware. This is in no way for the purpose of adding to the acid-resisting properties, but is simply to give a finished appearance. Finally, the fires are permitted to die down and the kilns to cool for three or four days before opening.

Fig. 13 is a close-up view of the interior of a kiln, with the finished ware in place. Note that the shapes are stacked on the brick checkerwork as mentioned above. The shapes vary in size from carboy stoppers to large receivers. No saggers or containers are used. In some cases bats separate the larger pieces to prevent fusion of the glaze. The maximum life of kilns burning this class of ware is about ten years, but arches, bag walls and fireboxes must be repaired every six months. It will be seen in comparing this picture of the burned ware with that of the unburned ware in Fig. 11 that they have become darker in appearance. They are in fact changed in color to a brownish red.

The ware is finally sent from kiln to finishing plant, where it is ground to accurate surfaces on revolving grinding tables using carborundum as an abrasive. All vessels undergo tests for ability to retain liquids.

APPARATUS MANUFACTURED

While some standard pieces are turned out, it is just as cheap to produce the desired ware from customer's blueprint. It is easily recognized from the foregoing paragraphs that the operations of manufacture require hand skill of individual craftsmen in every stage, which of course is as readily applied on special pieces as on the standard. Order number and blueprint number are stamped and burned in every article.

The field of use for chemical stoneware embraces acid manufacturers, acid users, etching plants, printing plants, photographic houses, electrolytic plants, paper mills, steel galvanizing and pickling plants, soap manufacturers, fertilizer producers, ink, dye, paint, insecticide and pharmaceutical manufacturers. Reclaiming plants for rubber and bleaching houses use a considerable variety of stoneware apparatus. Producers of organic chemicals of all sorts and even laboratories in the industries employ some small chemical stoneware utensils, such as sinks, waste pipe lines, burner guards, funnels, pitchers, filters and jars.

An acid-proof cement, high in silica and free from soluble salts, is ground in pebble mills to pass 80-mesh screen and bagged for the market. It may be used in chemical plants in the construction of masonry work which will come in contact with hot or cold, strong or weak and liquid or gaseous acids. This powder is mixed on the job with enough 30 to 40 deg. Bé. silicate of soda solution to make a uniform stiff mortar. About forty parts by weight of the solution is required for one hundred parts of cement powder. The cement will harden at ordinary temperature with free access of air.

ORGANIZATION

Every workman in the plant is his own foreman, an ideal condition for the development of true craftsmanship. There is no piece work whatever. The entire organization is headed by one general manager and his assistant. The whole forms a body of contented workmen functioning through personal contact with one head.

The writer is indebted to Maurice A. Knight for courtesy and information furnished in the preparation of this article.

Synopsis of Recent Chemical & Metallurgical Literature

Measurement of Surface Tension.—A. W. Fahrenwald, ore dressing engineer of the Bureau of Mines, has devised a simple instrument for measuring the surface tension of liquids by measuring the pull required to rupture a film of known width. A full description is given in the August 13, 1921, issue of *Mining and Scientific Press.* As shown in the accompanying illustration a 2½-in. cork C is pivoted on knife edges D and carries a pointer E indicating equal horizontal movements of the center of gravity of the pointer.

Over the cork is swung a No. 50 cotton thread, counterweighing a silver or aluminum bar K whose horizontal member (6 cm. long) is sharpened into a knife edge below. Small horns at the end are to prevent the film pulling away at the ends.

If the watch glass J containing the liquid to be measured is raised by means of band-wheel F until the liquid engages the knife edge, and then slowly lowered, a plane film will
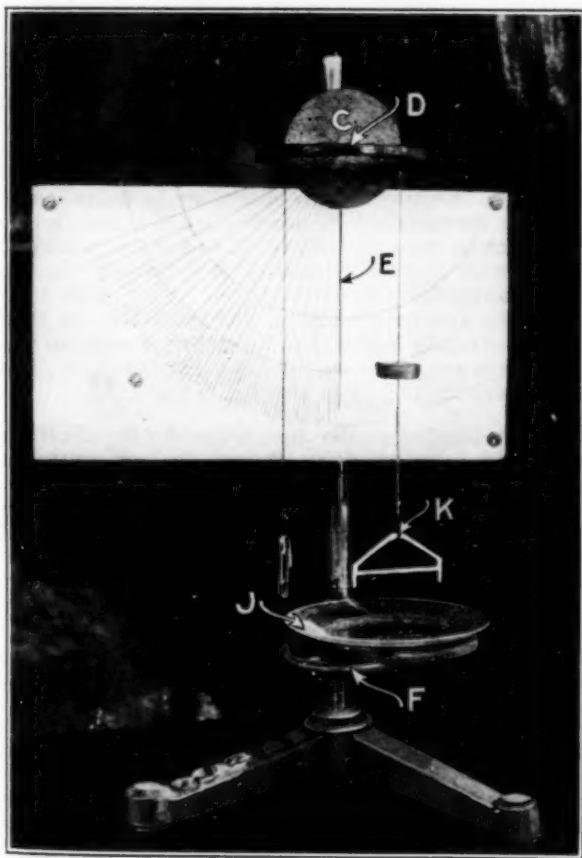
DEVICE FOR MEASURING SURFACE TENSION

be drawn out. Tension existing in this film rotates the indicator. Two characteristic points will be observed. The first breaking in water, for instance, will swing the pointer up to about the 80 dyne graduation, as the upper surface of the horizontal bar comes through the surface film. Then as the liquid is lowered further, a film will be drawn from the lower edge, and the pointer will drop to a constant reading, representing the true tension.

The method is independent of the wetting of the bar by the liquid to be tested. It measures the force required to break a film of considerable length, and the experiment can be done in a few seconds.

The conversion formula is

$$S = \frac{981W}{2L}$$

where S is the surface tension in degrees per centimeter; W is the weight in grams producing the same deflection in the pointer; 981 dynes equals one gram and L is the width of film. The influence of the horns may be estimated by drawing a film from them without touching the knife edge to the surface.

Using this method, the surface tension of water at 20 deg. C. figures 92.85 dynes per cm., a figure in close agreement with the most accurate figures published.

Critical Review of Wet Process for Manufacture of Portland Cement.—The question whether the wet or dry process is best for the manufacture of portland cement from hard, dry raw materials is still an open one in this country. A critical comparison of the two processes was made by Richard K. Meade in the Cement Mill Section of *Concrete* for May, 1921.

The author first considers in detail the following advantages claimed for the wet process:

(1) That a better and more uniform cement can be manufactured by the wet process than by the dry, owing to the fact that a more satisfactory mixture of the raw material can be made, a more constant composition can be maintained, and the particles of material can be brought into more intimate contact.

(2) That wet materials can be more easily ground than dry, the operation requiring less power and the repair item being less. That the output of the mills is also greater, which decreases the investment in the plant and consequently lessens interest, depreciation, etc.

(3) That the raw materials do not need to be dried, which effects a saving of the fuel and equipment necessary for this, with the labor, power, repairs, overhead, depreciation on the latter, etc.

(4) That the clinker of the wet process is more easily ground than that of the dry.

(5) That wet materials are more easily handled than dry.

(6) That there is less dust connected with the wet process than with the dry.

Turning to the advantages of the dry process, the author states that these lie almost entirely in the fact that less coal is employed for burning. Data on the fuel requirements of the two processes are tabulated for eight plants with dry process rotary kiln (three plants using oil and five powered coal as fuel) and for six plants with wet process rotary kilns (three using gas and three pulverized coal). The average heat requirements per bbl. of cement were found to be 1,219,000 B.t.u. for the dry and 1,696,317 B.t.u. for the wet, a difference of 477,317 B.t.u. Since good Pennsylvania and West Virginia gas slack has a heating value of approximately 14,000 B.t.u. per lb., this difference is equivalent to 34 lb. of coal.

It has long been recognized that the rotary kiln is wasteful of heat and that its actual efficiency probably does not amount to more than 25 per cent. Most advocates of the wet process have held that the other 75 per cent could be very

TABLE I. HEAT LOSSES OF THE ROTARY KILN	
	Per Cent
Carried off by the hot clinker	13
Carried off by the stack gases	40
Utilized to decompose carbonates	27
Lost by radiation, etc	20
Total	100

readily put to useful work in driving off the water from the wet slurry. A review of the heat balance of the rotary kiln, however, shows that this is by no means the case. Table I may be said to summarize fairly the situation in a dry process plant.

Even a glance at Table I will show that the only portion of the loss which can be utilized in evaporating water is that represented in the waste gases, or, in other words, 40 per cent of the total heat of the fuel and not 75 per cent. It would not be possible, however, to recover even all of the 40 per cent carried off by the waste gases because some

heat would have to remain in the gases to produce draft, unless fans were used.

The percentage of water in the slurry of the wet process varies considerably. As a general rule, however, at least ½ of the slurry is water, or about 300 lb. per bbl. of cement.

To evaporate 300 lb. of water from an initial temperature of 60 deg. C. would require 336,720 B.t.u. In the dry process, assuming 87 lb. of coal per bbl. of cement and 10 per cent excess air, there would be about 1,233 lb. of waste gases leaving the kiln at 1,600 deg. F. and containing 545,552 B.t.u. If the gases were to leave the kiln at 400 deg. F.—a temperature sufficient to produce the necessary draft—they would contain only 119,048 B.t.u., or 426,504 B.t.u. less than at 1,600 deg. F. This difference is more than sufficient to evaporate the 300 lb. of water and heat the vapor to 400 deg. F. (336,720 B.t.u. + 54,000 B.t.u. = 390,720 B.t.u.). Thus it is seen that 87 lb. of coal would produce a barrel of cement by the wet process provided that the waste gases left the kiln at 400 deg. F. In practice, however, the temperature of the waste gases from a wet process kiln is from 800 to 1,100 deg. F. This accounts for the greater fuel consumption.

By the use of waste heat boilers a final temperature of 400 deg. F. may be reached. In the dry process, as indicated above, the 1,233 lb. of gases at 1,600 deg. F. containing 545,552 B.t.u. can give up 390,720 B.t.u. in cooling to 400 deg. F. This is equivalent to 11.6 boiler hp., or 401 lb. of steam at and from 212 deg. F. If delivered to a modern turbine plant (which is usually rated at 17.5 lb. of steam at 200 lb. pressure and 100 deg. superheat per kw.-hr.) the power output would be 20 kw.-hr. Approximately 10.5 boiler hp. is being actually recovered per bbl. of clinker in many plants. In some instances this steam is being used in old equipment, but where employed in modern turbine installations, an output of 16 to 18 kw.-hr. is being obtained, or enough to operate the entire plant, including both clinker and raw mills.

It is, of course, possible to install waste heat boilers with wet process kilns, but in this case 121 lb. of coal gives about 2,000 lb. of gases at about 900 deg. F. containing approximately 500,000 B.t.u. While the total heat in the waste gases is about the same as in the dry process, more coal has been required and the greater volume of gas, coupled with its lower temperature, makes the amount of recoverable heat much less than in the dry process.

In conclusion the author points out that the possible saving of the wet process in grinding and drying is much more than offset by the saving of the dry process in fuel, while the advantages claimed for the wet process as to lack of dust and better quality of product are not borne out by either facts or theories.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Decolorizing Carbon.—A decolorizing carbon is prepared from the waste filter-press residues from the refining of edible oils, such as cottonseed oil or shea-nut oil, by heating them in a reverberatory or similar furnace at a temperature just above the flash-point of the oil they contain, and with restricted admission of air. The product, which is a porous carbonaceous mass, is cooled out of contact with the air, washed with dilute acid to neutralize any alkaline salts formed by the incineration of contaminating soaps, and finally pressed into cakes and dried. Lampblack is collected as a combustion product in the flue of the furnaces. (Br. Pat. 162,117; De Bruyn, Ltd., and C. Revis, both in London; June 15, 1921.)

Electrolytic Production of Boron.—Boron is produced by electrolysis of fused boric acid made conductive by the addition of a suitable substance such as borax. Both electrodes may be metallic or the anode may be of retort carbon. Carbon monoxide and carbon dioxide formed in the latter case assist in the operation. The process is carried out in a closed vessel having an outlet pipe for gases. The vessel may be of insulating material or of metal and in the latter case forms the cathode. The cables pass through the wall of the vessel or through the cover. Boron so produced may be used as a reducing agent in metallurgy. (Br. Pat. 162,252, not yet accepted; C. Constant and V. Raisin, both of Paris; June 15, 1921.)

Electric Furnace.—In an electric furnace pairs or groups of electrodes of uniform thickness are brought into contact and are maintained in contact by hand or by automatic devices. Means are provided to permit the substitution of new electrodes when the old ones are nearly consumed. Meters are preferably used with each pair of electrodes to facilitate the control of the voltage. A high current density is used so that heat generated through the resistance of the electrodes themselves contributes to the general heating effect. The arrangement is stated to be applicable to rotary furnaces consisting of a horizontal cylinder of large diameter provided with lateral cylindrical or conical drum-shaped extensions of a less diameter. The electrodes are introduced through the walls of the cylinder around the extensions which may be used for charging. (Br. Pat. 162,-285; not yet accepted. A. H. Pehrson, Stockholm; June 22, 1921.)

Catalytic Hydrogenation of Fats.—A catalyst for use in the hydrogenation of fats or oils consists of nickel wool which has been activated by the action of an acid such as nitric acid upon its surface followed by conversion of the layer of nickel salt to oxide and reduction in hydrogen. The reaction chamber is packed with the activated nickel wool and the oil and hydrogen passed through in counter-current. After use the catalyst is regenerated by first removing nickel soaps by washing with the hot oil, then removing the oil by solvents and finally heating in hydrogen. According to the provisional specification, the nickel wool may be activated by alternate oxidation and reduction, the catalyst may be electrically heated, and a number of reaction vessels may be arranged in series. (Br. Pat. 162,370. E. R. Bolton, London; June 22, 1921. See also Br. Pat. 162,382.)

Cleaning Electrolytically Iron or Iron Alloy Surfaces.—Iron or iron alloy surfaces which are to receive a deposit are electrolytically cleaned in an acid solution of a copper salt. A suitable solution contains 10 to 12 per cent of sulphuric acid and 5 to 10 per cent of copper sulphate. If the surface is very dirty, it is connected first as cathode and then as anode; otherwise it may be employed as anode only. A current density of 150 to 500 amp. per sq.ft. and a pressure of 8 to 20 volts may be employed. The other electrode may be of lead and may form the lining of the vat. Temperatures from that of the atmosphere up to 120 deg. F. are allowable. Grease is removed before the above treatment. After the electrolytic cleaning the surfaces may be directly coated with iron, nickel or cobalt. Worn surface of machinery may be refaced by this process, the deposited iron being case-hardened if desired. (Br. Pat. 162,391. R. J. Fletcher, London; June 22, 1921.)

Process for Desulphurizing Iron and Steel.—In a process for desulphurizing iron and steel the iron bath is freed from phosphorus, manganese, etc., and the slag layer is removed and replaced by a new thick layer of highly basic slag into which specially prepared carbon, having approximately the same specific gravity of the slag, is immersed for the purpose of converting in a neutral atmosphere the sulphur into calcium sulphide and at the same time remove the last traces of oxygen in the form of carbon monoxide. The carbon is prepared by mixing finely ground coke with tar and forming the mixture under great pressure into blocks provided in some cases with perforations. When required, the slag bath is regenerated after the molten iron has been removed, by passing a current of air over or through the slag. (Br. Pat. 162,618; not yet accepted. Koppers, Essen, Germany; June 22, 1921.)

Current Events
in the Chemical and Metallurgical Industries

Embargo Extension Bill Passed by House

The Longworth bill extending the embargo on dyes and chemicals was passed by the House on Aug. 11 by a vote of 186 to 91. The action was taken promptly after the receipt of the following letter from President Harding to Representative Longworth:

I have your note calling my attention to the fact that the bill extending the provisions of the emergency tariff act relating to the protection of the American dye and chemical industry is to be before the House on the morrow. I am sure that the Secretary of the Treasury has already called the attention of your committee to the extreme desirability of extending this protective provision. Surely, we would be both unmindful and unjust if we failed in a suitable protection of this industry until the new and complete tariff revision act is made effective.

In recommending the passage of the bill, the committee submitted the following:

Under the present emergency tariff law the provision relating to the control by the Government over importations of dyes and chemicals expires three months after the date of the approval of the act—namely, on Aug. 27, 1921.

It now seems evident that the permanent tariff law will not be enacted until some months thereafter. Therefore, during the time elapsing between Aug. 27 and the final enactment of the tariff law the rates of duty of the Underwood law would apply to all importations of dyes and chemicals. These rates of duty are admittedly insufficient to prevent importations of enormous quantities of these chemicals to an extent sufficient to seriously menace or even destroy the American coal-tar and synthetic chemical industry.

Dye Embargo Argued Extensively at Senate Hearings

The dye embargo still hangs in the balance before the Senate Committee on Finance at the time of this writing. The hearings were prolonged unexpectedly. The committee had planned to terminate those on the dye embargo and on the American valuations a full week sooner than it did. The importance of this concession can be realized only by those having first-hand knowledge of the pressure under which the Finance Committee is working as a result of the pending tariff and taxation legislation. The extension of the hearings signifies that the Finance Committee attaches the greatest importance to the proposal that more than duties are required to protect the dye industry. Owing to the important bearing that these two matters will have on the action which the committee will take on the remainder of the tariff bill, an early decision is to be reached in the matter of the dye embargo and the type of valuation which is to be used.

LETTER FROM THE SECRETARY OF WAR

As a result of the extension of the hearings a very full presentation has been made of the entire dye proposition. One of the most important points emphasized in favor of the embargo was the relation it has to the national defense. The Secretary of War, who for many years was a member of the Senate and whose opinion has great weight with that body, wrote a forceful letter to Senator Penrose, the chairman of the Finance Committee, in which he urges the embargo in the interest of national defense. His letter, in part, is as follows:

One of the most startling discoveries of the World War was the fact that the United States could mobilize, train and equip with clothing three or four million men far quicker than it could supply the cannon, the rifles, and the ammunition for them. Notwithstanding that from 1914 to 1917 our great steel industries and our rapidly developing chemical industries had been working feverishly to increase their facilities to supply ammunition and guns to the Allies, it was more than a year after we entered the war before those industries were able to supply ammunition, war gases, guns and rifles to meet American needs. Even then our chemical industries were so undeveloped in 1917 that it was necessary for the Government to build tremendous high explosive plants, as at Nitro, W. Va., and practically all poisonous gas plants for supplying gases and smoke materials to the United States Army.

The use of high explosives and war gases will unquestionably be far greater in any future struggle than in the World War. Inasmuch as the coal-tar industry, which is the base of all dyes, is also the base of all high explosives and most of our war gases, it is of the most vital importance to preparedness that the dye industry be developed to the fullest possible extent in this country. It is felt that this danger is so great that I urge the enactment of the embargo feature of the Fordney tariff bill as submitted by the Ways and Means Committee of the House as the only way to prevent crushing our chemical market by German competition.

CONSIDERATIONS URGED BY DYE MANUFACTURERS

Joseph H. Choate, representing the American Dyes Institute, was examined at length by the committee. His testimony necessarily covered the same ground many times, due to questions asked by members of the committee duplicating questions which had been asked previously by another member. Among the considerations which Mr. Choate urged as proper in governing the final decision of the committee are these:

First. Now, and now only, can we secure a real dye industry. While the Germans retain their present advantages, and the power and necessities of the great trust compel that attack which we deem inevitable, their commercial warfare will instantly kill our industry unless whatever protection is provided is truly efficient. Once killed, it could never be revived. If it be not saved now and promoted as well as protected, American capital will never again go into it, and a world monopoly will be handed back to Germany for all time.

Second. Since it is certain that there will never be another opportunity to provide the United States with a real dye industry, it is the duty of Congress, if it believes such an industry to be essential, to take no chances. The stake is too great for any gamble; and to adopt any method of protection with doubt as to its efficacy is to gamble with an interest vital to the whole country. According to the overwhelming weight of the testimony, we submit, no tariff practically enactable can furnish the protection needed.

Third. Only the complete protection and efficient promotion of our dye industry can insure the safety of the textile makers themselves. As long as the German industry is in one single hand, and that hand at the disposal of its government, it can and will be used to further any national ambition.

Fourth. If capital is to be attracted into and kept in the dye industry the necessary special protection must be assured for a period long enough to permit the development of most of the missing dyes. The testimony leaves no real doubt that three years is wholly inadequate.

CHOATE ANSWERS ARGUMENTS OF METZ

By far the most formidable witness who appeared in opposition to the embargo was Herman A. Metz of New York. Realizing that, Mr. Choate took pains to answer his arguments in detail. Among the things which Mr. Choate told the committee in that connection is the following:

Mr. Metz gave no figures anywhere as to the manufacture of dyes which would support his contention that the industry can survive in this country when protected only by an ordinary tariff. He laid great stress, however, upon the manufacture of salvarsan. As to that, I would like to have the committee remember that

he told you that salvarsan was a product in making which no byproducts were produced. That sort of manufacture is relatively simple when compared with the enormous complications of dye making, involving a great many byproducts, which are really the key to the situation.

It is true that he did reduce the price from $2.25 to 27c. That shows the remarkable effect of the competition to which he was subjected, and it also shows that the pre-war price in our market of a commodity on which the Germans had a monopoly was probably excessive.

Mr. Metz says that dye plants are no more fitted for the manufacture of explosives than are breweries. Notice that he does not say that they are not fitted for making poison gas. He does not attempt to contradict General Fries on that. He says the only dye plants good for war purposes are those which include nitrating plants. All considerable dye plants have nitrating plants, and a very large proportion of the dyes that are made require nitrating sooner or later. He says there are only eight plants in the country that nitrate. In that connection permit me to say that one of the witnesses to be heard later will show the existence of at least thirteen plants which nitrate.

Mr. Metz says, "I am not afraid of the Germans." Why should he be? Just before that he had said, "I am a representative of the great Hoechst concern."

DEFENSE OF WAR TRADE BOARD

Vigorous denial that the War Trade Board has shown favoritism in issuing import trade permits was made by Henry B. Thompson, chairman of the advisory committee, War Trade Board. It had been alleged by an earlier witness that he had applied for a permit for a certain product from Germany, but was turned down with the explanation that it could be had in this country.

Mr. Thompson told the committee that he was a manufacturer and that he dyed cotton goods and certain lines of the textile industry. He said that in all his experiences with American dyes they answered his purposes splendidly and that he expected to continue to use them, despite any importation of foreign colors.

"Give the American manufacturer an opportunity to produce what is wanted," Mr. Thompson said. "The only thing we lack today, I must admit, are certain vat colors, but we can get along without them. The industry in America has made wonderful progress, and as soon as we are able to get together an efficient staff of organic chemists we shall gladly meet competition. The cry for German dyes has caused no one any serious suffering. We can match any shade—that is, we can match it in a way that will be acceptable to the trade."

HOSIERY MANUFACTURERS OPPOSE EMBARGO

George Demming, representing the National Association of Hosiery and Underwear Manufacturers, declared that Henry B. Thompson, who appeared as a representative of the advisory committee of the State Department in matters pertaining to dye imports, made the following assertion to the Finance Committee nearly two years ago:

"It is true we do not make the vat dyes in this country, and it is true that the mill men should have them. They must have them. But we expect to have them in six months or a year."

Mr. Demming cited that language in an effort to discredit Mr. Thompson's statement that the embargo could be dispensed with after three or four years. Senator Smoot suggested that it would take fifty years of embargoes to give the dye makers the encouragement that they desire.

Mr. Demming, continuing along the same line, said: "Two years ago Nicholas Longworth, one of the principal proponents of this present proposed legislation, got up on the floor of the House, and in the most emphatic and deliberate way, in a prepared speech, said that all that the American domestic dye manufacturer needed was two years of an embargo, and that then they could turn out all these dyes and take care of ourselves. I remember hearing that speech. We have had that embargo for over two years, and now they want three years more of it."

At another point in his testimony Mr. Demming said: "The licensing law in England is not only a very different law from that proposed here, as I will show to you, but it

is also for the protection of a company over there in which the government participates and which the government controls. Now that is very different from the embargo and licensing proposed here for the benefit of private individuals to roll up any profit for themselves that they can under the umbrella of that embargo and licensing."

CHEMICAL WARFARE HEAD TESTIFIES

The Finance Committee paid particularly close attention to the testimony of General Fries, head of the Chemical Warfare Service. A brief extract from General Fries' testimony follows:

We have felt that the embargo was a success during the war in building up this industry from, say, 7 plants to 82, and that if it had done that during this time, the embargo, continued for some time, would eventually develop our industry to the point where we would be making practically all the dyes that Germany is making and we would be utilizing all of the coal-tar products. In other words, before they do that they have got to change over many beehive coke ovens to those that will save the coal tar.

Looking at it from the result before the war, when we had a duty on dyes and when we had made practically no progress, and looking at the progress we made under the six- or seven-year embargo due to the war, which was a total embargo, it would seem the part of wisdom, to me, to continue that embargo long enough to develop the other 40 per cent of these coal-tar products and the other 500 or 600 dyes that are not made in this country.

SENATOR DEMANDS FACTS

Senator Watson, of Indiana, at one point during the hearing, gave expression to the following:

Men who are opposed to the embargo get themselves into a frame of mind where they are willing to believe that Germany is not making dyes, while the men who are in favor of an embargo get themselves into a frame of mind where they are willing to believe that unless we enact some legislation soon Germany will flood us with dyes in thirty days and thereby destroy the dye industry in America. Why do you not get down to facts and tell us whether the American industry can be saved in the absence of an embargo and whether or not the American valuation plus a certain rate will protect the American industry?

Chemical Warfare Training Plan Outlined

The War Department has issued the following order to govern the training and the instruction of the Army in chemical warfare:

1. The conduct of a special service school for the training and instruction in chemical warfare, both offensive and defensive, for the following:

(a) Selected officers of the Chemical Warfare Service for preparation for duties as gas officers for divisions, corps and armies and for other technical duty in the Chemical Warfare Service.

(b) Selected non-commissioned officers of the First Gas Regiment for preparation for emergency commissions.

(c) Selected officers and non-commissioned officers of combatant arms in the duties of regiment and battalion gas officers and non-commissioned officers. Officers and non-commissioned officers so instructed will be available as instructors in chemical warfare in their own units.

(d) Selected officers and non-commissioned officers of the National Guard and Organized Reserves for duty as stated in paragraph (c) above.

2. Provision for officers of the Chemical Warfare Service as instructors in both offensive and defensive chemical warfare at General Service Schools and at certain Special Service Schools as directed by the War Department.

3. Provision for personnel of the Chemical Warfare Service for representation upon the staffs of corps areas, departments and divisions.

4. Provision for the availability of such portions of the First Gas Regiment as are necessary for demonstrations and for instructional purposes at Special Service Schools.

5. Provision for suitable units of special gas troops for corps areas and departments during periods of field training and the operation of such troops during these periods.

Joint Meeting of T.A.P.P.I. and Paper Mill Superintendents

The joint fall meeting of the American Pulp and Paper Mill Superintendents' Association and the Technical Association of the Pulp and Paper Industry will be held at Washington, D. C., York, York Haven and Spring Grove, Pa., Oct. 18 to 21, 1921. Closing meetings will be held at Philadelphia and Wilmington. As now arranged, the first day of the meeting will be spent in Washington with headquarters at the industrial building of the Bureau of Standards. The second day will include mill and plant visitations in York, York Haven and Spring Grove, the third day will be spent in Philadelphia and the fourth in Wilmington.

A revised draft of the program of meeting and mill visitations follows:

TUESDAY, OCTOBER 18

9 a.m.—Assembly at industrial building of the Bureau of Standards for reading and discussion of papers and group meetings arranged by T.A.P.P.I. Service Committee, and committee of A.P. & P.M.S.A.

12:30 p.m.—Luncheon, Bureau of Standards.

2 p.m.—Inspection of sections of the Bureau of Standards; visits to paper and dye laboratories of the Bureau of Chemistry; optional visits to Government Printing Office, Bureau of Engraving and Printing, and mill of District of Columbia Paper Manufacturing Co.

7 p.m.—Supper at New Willard Hotel, followed by smoker and continuation of papers, group meetings and discussions.

12 p.m.—Take Pullman cars for York, for visits to York, York Haven and Spring Grove, Pa.

WEDNESDAY, OCTOBER 19

Breakfast on arrival at York. Visits to plants in York and York Haven, followed by trip in afternoon to Spring Grove. Leave York for Philadelphia in evening.

THURSDAY, OCTOBER 20

Breakfast in Philadelphia at Bellevue-Stratford, association headquarters, where members and guests will register for visits to the various mills and plants to be inspected during the day.

7 p.m.—Banquet at Bellevue-Stratford.

FRIDAY, OCTOBER 21

Excursion to Wilmington, Del. Leave Philadelphia for Wilmington by early train. Breakfast at cafeteria of Pusey-Jones Co. on arrival, followed by visits to following plants: Pusey-Jones Co., du Pont company's plant at Carney's Point, inspection of laboratory of dye works of the du Pont company.

The chairman of the local committee of arrangements is Fred A. Curtis, chief of paper section, Bureau of Standards, Washington, D. C.; Grellet N. Collins, of Dill & Collins, Philadelphia, is in charge of arrangements for Philadelphia district; W. S. McClellan, of P. H. Glatfelter Co., for the York district, and Harvey G. McDowell for Wilmington.

American Tar Products Co. to Build New Chicago Plant

The American Tar Products Co., a $5,000,000 corporation with plants in St. Louis, Milwaukee, Youngstown, Birmingham and Steubenville, Ohio, has purchased approximately forty acres at the southwest corner of Pershing Road and Fifty-second Ave., Chicago, upon which it will construct a new plant. The ground has already been broken and contract entered into to purchase the byproducts of the Chicago Byproducts Coke Co., materials being conveyed by pipeline from the latter plant. The operations carried on will involve the reduction of a large number of byproducts from coal tar, including roofing, waterproofing, wood preservatives, creosote oil and other products. An extension of the Illinois Central R.R. is to be constructed into the plant, which is also located on the Chicago & Illinois Western R.R. and the drainage canal. This company is building barges to carry raw materials from points on waterways to the plant and also will have several hundred tank cars in operation. Samuel H. Bingham is president of the company.

Chemical Exposition Notes

GLASS AND PORCELAIN

Glass and porcelain for the chemical industries will occupy an important position in the exhibits at the Seventh National Exposition of Chemical Industries, to be held in the Eighth Coast Artillery Armory, New York, Sept. 12 to 17. There will be a remarkable display covering a wide range of optical measuring instruments, photomicrographic apparatus, photographic lenses, microscopes, projection apparatus, ophthalmic lenses and instruments, range finders and gun sights, searchlight reflectors, stereo-prism binoculars, magnifiers, cups and cylinders.

A complete exhibit of glass enameled iron and steel equipment, small laboratory utensils, stills, evaporating dishes, condensers, cascade dishes, vacuum pans, autoclaves and tilting kettles will also occupy space, where reduction of costs and improving operations will be explained by experts.

Chemical and scientific porcelains for laboratory uses will hold a place of importance. Special stress is laid on heat resistance in these wares. Crucibles which do not crack or become unfit for use after several heats are of great interest to the chemist or scientific experimenter.

It is reported that dishes made from a glass composition which is entirely unaffected by nitric, sulphuric and hydrochloric acids, regardless of temperature or concentration, and offers great resistance to the action of phosphoric acid, casseroles perfected to meet the requirements of chemical and steam baths, will be a part of this display.

New Chemical and Oil Companies

During the month of July a total of twenty-nine companies was organized, with capital of $50,000 and over, to manufacture chemicals, chemical byproducts, drugs, dyes and affiliated products. The aggregate capitalization was $3,265,000, representing a slight decrease as compared with the corresponding figures for the month of June, set forth in a recent issue of CHEMICAL & METALLURGICAL ENGINEERING. The decline, as compared with the same month of 1920, is marked, for in July, 1920, the total capitalization of chemical organizations reached $21,475,500. For the first seven months of the present year the total indicated investment of new companies in this line stands at $68,890,000; the figures for the same period in 1920 approximate $131,207,000.

During the same month sixty-nine companies were chartered with capital of $50,000 in the oil industry, with total indicated capitalization of $38,777,000, the smallest figures for any month of the present year. As compared with the preceding month of June, the decrease was $13,843,000. In July, 1920, a year ago, the record was $116,841,000.

European Nitrogen Developments

A supplementary report issued by the British Nitrogen Products Committee states that Brunner Mond & Co., Ltd., in addition to taking over the government factory at Billingham, has organized a subsidiary company, which is concentrating its attention on the design of a new nitrogen-fixation plant with an annual capacity of 7,000 tons of fixed nitrogen. It is also reported that a company to be known as Cumberland Coal, Power & Chemicals, Ltd., has been organized for the purpose of manufacturing synthetic ammonia under the patents of the Claude process.

Germany's productive capacity for synthetic ammonia in 1920, according to a report just issued by the German Government, was 424,000 tons, as compared with 247,300 tons for the rest of the world.

Pottery Workers Accept Wage Reduction

At a conference between the United States Potters' Association and the National Brotherhood of Pottery Operatives at Atlantic City, N. J., Aug. 5, the employees agreed to an immediate reduction of 10 per cent in wage scale, with an additional 9 per cent reduction in January, 1922. At the different sessions it was set forth that the pottery industry at the present time is operating at less than 50 per cent of normal, without very encouraging outlook for early resumption.

Plans for the Symposiums on Gas Chemistry and Filtration at New York Meeting, A.C.S.

The plans of the Division of Industrial and Engineering Chemistry of the American Chemical Society outline two series of papers and discussions which should prove extremely interesting to many industries. The symposium on gas chemistry, which will be held on the afternoon of Sept. 8, will be devoted to four principal subjects: Coke-oven problems, low-temperature carbonization, gas works control, and gas analysis and its applications.

FORMATION OF SECTION ON THE CHEMISTRY OF GASES AND FUELS IN PROSPECT

If the interest in the program and problems presented at the symposium seems to justify it, plans may be made for the formation of a regular section of the society to deal with the chemistry of gases and fuels. It is emphasized by the committee in charge of the meeting, C. H. Stone, H. E. Howe and R. S. McBride, that the symposium will deal with the chemical problems rather than with engineering problems which are commonly considered at the meetings of the American Gas Association. However, it is hoped that the co-operation and attendance of all engineers as well as chemists will be had.

Further suggestions regarding speakers or subjects which receive attention at the meeting should be addressed to the secretary of the symposium, R. S. McBride, 610 Colorado Building, Washington, D. C. Those having articles which they desire to present at the September meeting on any phase of gas or fuel chemistry should send the abstract of their paper with title and author to H. E. Howe, Marine Biological Laboratory, Woods Hole, Mass., on or before Aug. 18.

FILTRATION SYMPOSIUM

Dr. D. R. Sperry, who has organized the symposium covering the different phases of filtration, announces that sixteen papers have already been promised for presentation at the meeting.

All papers are to be illustrated with lantern slides, whenever possible, and a full opportunity will be given to members to question the authors.

The subjects to be treated include: Theory of filtration, rates of flow, general operating experiences, filtration apparatus, general engineering experiences, filter bases, plate and frame filter presses, suction filters, dumping filters, squeezing filters, centrifugal filters, pulp filters, new ideas in filtration apparatus, filter cloths, filter papers, filter alloys and crystalline filter bases.

Wilkes-Barre Meeting of the American Institute of Mining and Metallurgical Engineers

The semi-centennial anniversary meeting of the American Institute of Mining and Metallurgical Engineers will be held at Wilkes-Barre, Pa., Sept. 12-15, 1921. Anthracite coal and its production will be the chief subject to be discussed, although a number of interesting papers are scheduled to be read before the Metal Section of the Institute. Convention headquarters will be at the Irem Temple.

PROGRAM OF THE MEETING

R. V. Norris is the general chairman of the local committee, of which Paul Sterling is the general secretary. The program of the meeting follows:

MONDAY, SEPT. 12

Coal Section

2:30 p.m.
"Mechanical Mining of Anthracite," by H. D. Kynor.
"The Ashley Planes," by C. H. Stein.
"Anthracite Preparation," by D. C. Ashmead.
"Anthracoal," by Donald Markle.
"The Slush Problem," by John Griffen.
8 p.m.
"The Lynch Plant," by Howard N. Eavenson.
"General Description Anthracite Field," with maps and sections, by E. W. Parker.

Metal Section

8 p.m.
"Application in Rolling of Effects of Carbon, Phosphorus and Manganese on Mechanical Properties of Steel," by W. R. Webster.
"Thacher Process for Molding and Casting Propeller Blades and Wheels," by E. Touceda.
"Making a 5 per cent Nickel-Cast-iron Alloy in an Electric Furnace," by D. N. Witman.

TUESDAY, SEPT. 13

In the morning automobile trip through Wyoming Valley, visiting breakers and mine plants. Leave Irem Temple, 9 a.m. sharp.
Luncheon as guests of the International Correspondence Schools, Scranton.
At 2 p.m. Technical Session in International Correspondence Schools auditorium.
Discussion on "Mine Fires," by Douglas Bunting.
"Electric Power a Factor in the Anthracite Field," by W. A. Thomas.
"Determination of Electrical Equipment for a Mine Hoist," by Graham Bright.
"The Automatic Substation for Coal Mines," by R. J. Wensley.
Also at 2 p.m. Americanization Session. Meeting of Committee on Industrial Relations for discussion of papers. Discussion will be introduced by E. E. Bach, Director of Americanization for State of Pennsylvania, and chairman of Institute subcommittee on Americanization.
Return to Wilkes-Barre by special train on Laurel Line.
8 p.m.
"The Hoisting Plant of the Pittsburgh Terminal Railroad-Coverdale Mine," by M. D. Kirk.
"Power Installation at Coverdale," by C. M. Means.
"Octagonal Ventilation Shaft of Davis-Daly Copper Co.," by J. L. Bruce.
"Application of Pulverized Coal to Boilers," by J. M. Fuller.

WEDNESDAY, SEPT. 14

9 a.m. and 2:30 p.m.
General joint meeting conducted by Society of Economic Geologists.
Papers of the Society of Economic Geologists and the following papers of the Institute:
"Stratigraphy of the Anthracite Region." Discussion led by James F. Kemp.
"Petroliferous Rocks in the Serra da Baliza," by E. P. de Oliveira.
"General Geology of Catorce Mining District," by C. L. Baker.
"Geology of the Namma Coal Field," by Edel Moldenke.
9 a.m.
Session on Mine Accounting. "Capitalization and Valuation of Mine Development," by J. B. Dilworth. (Discussion).
Luncheon. Complimentary to members and guests of the Institute at the Wyoming Valley Shovel Works.

General Technical Session

2:30 p.m.
"Queen Nine-hearth Roaster," by J. Moore Samuel.
"Flotation of Pyrite," by W. S. Morley.
"Relation of Gypsum Supplies to Mining," by D. H. Newland.
(Members may attend, instead, trips as arranged by the Ladies' Committee.)
8 p.m. Dinner and ball at the Irem Temple given to the visiting Institute members by the Anthracite Section.

THURSDAY, SEPT. 15

All-day excursion by automobile, starting from Irem Temple at 9 a.m. sharp. Lunch en route.

FRIDAY, SEPT. 16

Visits to points not provided for in the program will be arranged for, as far as practicable, after adjournment on Friday, if members will make their desires known to the local committee.

New Chemical Laboratory, Yale University

The new chemical laboratory at Yale University, New Haven, Conn., contract for which has recently been awarded to the Thompson-Starrett Co., 49 Wall St., New York, will occupy a portion of the Pearson-Sage Square, near the present Sloan Physics Laboratory. It will have a ground floor area of about two acres, with extensive space given over to private research laboratories, general chemical laboratories, recitation rooms, lecture rooms and library. The exterior will be of brick and brownstone, with slate roof to harmonize with neighboring structures. The building will be known as the Sterling Chemical Laboratory, and is estimated to cost about $1,500,000.

Zinc Dust in 1920

The zinc dust produced in the United States in 1920, as reported to the U. S. Geological Survey by twelve plants, showed an increase in 1920 as compared with 1919 of over 70 per cent in both quantity and value.

ZINC DUST PRODUCED IN 1919–1920

	1919			1920		
	Quantity (Short Tons)	Value Based on Sales	Average Price per Lb. Cents	Quantity (Short Tons)	Value Based on Sales	Average Price per Lb. Cents
Prepared "Blue powder"	4,083	$801,366	9.8	9,066	$2,009,117	11.1
"Atomized" zinc dust	2,515	524,694	10.4	2,273	512,833	11.3

Personal

N. E. AUSTIN, of New York, has resigned as treasurer of the Triangle Commercial Corporation, to become connected with the Eli Chemical Products Co., Inc., 206 East 128th St.

G. A. BOLE has resigned his position as professor of chemistry at Alfred University, Alfred, N. Y., to become associated with the ceramic station of the Bureau of Mines at Columbus, Ohio.

J. P. BONARDI has resigned from the Bureau of Mines, with which he has been associated for the past five years, to accept the position as manager of the assay and chemical department of the Mine & Smelter Supply Co., Denver, Col., beginning his new duties Aug. 15.

WILLIAM BURGESS, of Trenton, N. J., recently appointed by President Harding as a member of the Tariff Commission, has resigned as vice-president of the United States Potters' Association. The office will be filled at the next annual meeting of the organization to be held at Washington, D. C., in December.

W. A. DALZELL, of Moundsville, W. Va., has been re-elected president of the Fostoria Glass Co. C. B. Roe has been re-elected vice-president and general manager.

Baron GERARD DE GEER has left the Domnarfvet Steel Works and is now manager of Nyhammars Bruks Aktiebolag, Nyhammar, Sweden.

J. R. DAVIES, formerly secretary of the Chicago Section, American Chemical Society, has been appointed chief chemist and assistant plant manager of the chemical works of the Calumet Baking Powder Co. at Joliet.

L. I. LOGHRY has resigned from the Mount Joy Magnesia Co., Mount Joy, Pa., and has accepted the position of chief chemist for the Knickerbocker Portland Cement Co., Hudson, N. Y.

G. ST. J. PERROTT, associate physical chemist of the United States Bureau of Mines Experiment Station, Pittsburgh, Pa., is to be sent to Birmingham, Ala., to study the physical properties of coke in relation to its production and use in the blast furnace.

W. N. ROACH, formerly engaged in patent work for the War Department, has left that service to start a private patent practice in Washington. Mr. Roach has been with the War Department since August, 1918.

L. I. SHAW, assistant chief chemist of the Bureau of Mines, has transferred his activities from Washington to the ceramic station at Columbus, Ohio, to co-operate with R. T. Stull in research on ceramics. His immediate work will be concerned with physical chemistry as applied to ceramics and involves work with colloids.

R. J. TAIT, chemist for the Grasselli Chemical Co., New York, has been transferred to the Cleveland, Ohio, office of the company, to be connected with the sales department there.

Obituary

DR. WALLACE CALVIN ABBOTT, president of the Abbott Laboratories, which he founded and built into one of Chicago's most prominent chemical establishments, died at his home on July 4. Born in 1857, he was educated at Dartmouth College and took the degree of M.D. at the University of Michigan in 1885. Dr. Abbott was a pioneer in the field of alkaloidal medication, and his incessant labors through his writings and his personal contact have made his influence on the medical profession in this respect profound. Dr. Abbott was co-author, with Dr. William F. Waugh, of "The Practice of Medicine" and of "Positive Therapeutics." He was editor-in-chief of *The American Journal of Clinical Medicine*, now in its twenty-eighth year.

GEORGE H. ELLIS, vice-president of the Chicago Section of the American Chemical Society in 1900, died on July 10. Mr. Ellis belonged to the earlier generation of chemists who did much for the development of industrial chemistry in the West. He was born in 1864 and received the B.Sc. degree from the University of Illinois in 1885. As chemist for the C. B. & Q. R.R. from 1885 to 1893 he acquired sufficient experinece to establish himself as a consulting chemist, maintaining an office in Chicago for ten years thereafter. A great deal of his attention was devoted to the paint trade, and in 1903 he became secretary and treasurer of the George W. Pilkin Co. In 1909 he was elected president of the Johnson Magnetic Paint Co., which office he held until his death. He was the author of "Notes on White and Tinted Paint Analysis."

HARRY M. GRAY, president and general manager of the Como Chemical Co. of Kokomo, Ind., a member of the Chicago Section, A.C.S., died at Kokomo on July 3.

PROF. CHARLES L. WEIL, consulting engineer, died at his home in Port Huron, Mich., July 16. Prof. Weil was actively identified with the Diamond Crystal Salt Co. as consulting engineer, and in addition maintained an engineering office in Port Huron. He was born in North Andover, Mass., in 1865. His engineering education was obtained in the Massachusetts Institute of Technology, from which he graduated in 1888. After a short period as draftsman with the Worthington Pump Co. he became instructor at Lehigh University, leaving there in 1893 to take charge of the engineering department of Michigan Agricultural College, where he remained for thirteen years. During his connection at M.A.C. Prof. Weil designed and installed a complete new power plant for the college which was a model of its kind at the time and most of which is still giving satisfactory service. He also instituted many important changes and improvements in the engineering department of the college. From M.A.C. Prof. Weil went to Detroit to engage in consulting work, later moving to Port Huron on account of the close connection which he established with the Diamond Crystal Salt Co. at St. Clair, at the same time continuing his consulting practice. Prof. Weil was probably the country's foremost engineer in the evaporation and manufacture of salt. His work was not limited to this phase of engineering, however, as he was active along many other lines, particularly power plant work. He was a member of the Detroit Engineering Society, Michigan Engineering Society and the American Society of Mechanical Engineers.

Current Market Reports

The Chemical and Allied Industrial Markets
New York, Aug. 15, 1921.

The chemical market during the past week presented no signs of pressing liquidation which seemed so persistently continuous early in the year and there was a little indication of speculative activity. The closing prices as a rule were very near the finals of the previous week. Prices generally are firmer, and although buying orders are still limited to small lots, as before, the number of such lots has been on the increase. Occasional orders for carlot quantities were heard during the week, especially in the cases of soda ash and fused sulphide of soda. Business all around would be much better were it not that the month of August is known as a vacation period and apt to be featured by the dullest trading of the year. Barium chloride buyers are becoming more confident as they realize that domestic makers will be unable to compete with importers' prices. Imported goods in most lines still figure largely on the market. Light soda ash did not vary much. Solid caustic soda touched $3.60 per 100 lb., which is the lowest figure recorded for the past few months.

Bichromate of soda held its own around formerly quoted prices and prussiate of soda was firm around 11¾c. per lb. Borax is finding a better market and leading producers say that considerable improvement has taken place in the amount of buying. The demand for this chemical has emanated from various sources. Muriate of potash was a shade easier and quiet. Bleaching powder is moving in very good shape at the works, with spot material rather scarce and prices firmer. Arsenic is experiencing the usual dullness incident to this period of the year. Consuming industries have not shown much departure from the conservatism lately displayed. Sales of several carlots of fused sodium sulphide were made around 5½c. per lb. It is believed that these purchases were made for use in the dye trade. Fair trading in imported caustic potash was noted around 4¼c. per lb. Soapmakers are buying this material. Caustic soda and soda ash have also prompted attention from leading soapmakers. Paper mills have bought quantities of bleaching powder at the works. Enamelers are showing more interest in borax. Textile mills are taking on miscelleaneous supplies of chemicals and dyestuffs, but are not inclined to operate far ahead. Tanneries are showing more interest in the market and laundry supply houses are taking on moderate quantities of oxalic acid and Japan wax.

CHEMICALS

Calcined carbonate of potash, 80-85 per cent, is obtainable at prices ranging from 5@5½c. per lb. The market is generally quoted at the outside figure by sellers. The movement has not involved large proportions during the past week, as buyers appeared satisfied to operate from hand to mouth. Higher grades are quoted up to 6½c. per lb., depending upon the quantity. Sales of imported *caustic potash*, 88-92 per cent, have been reported at 4¼@4½c. per lb., and it is possible that 4c. would be accepted in some directions on a firm offer for a round lot. Consumers have taken on large quantities of this chemical and are showing fair interest in additional supplies. Competition is naturally keen to get what business is passing and this is accountable for the irregularity displayed in quotations. Prominent sellers of imported *muriate of potash* quote the market at 85@90c. per unit of K₂O. This is equivalent to approximately $42.50@$45 per ton. The market has been a tame affair with inquiries and offerings rather limited. Rumors are current that domestic *barium chloride* makers are seriously considering the abandonment of further attempts to manufacture, in which case they expect to take over agencies for foreign producers. Prices now named for spot delivery of imported prime white material is $52 per ton and shipment goods is offered openly as low as $46 per ton. Buyers

are much more confident in the market at these figures and sales in good quantity are reported by all holders. Domestic makers were not offering or quoting any material. Resale *caustic soda* of standard make has sold at prices extending from $3.60@$3.70 per 100 lb. The inside price was quoted ex-store and the outside ex-dock. Dealers have experienced a fair call for this chemical for domestic use, but transactions have been similar to those of other items—namely, small lots. At the works, producers quote 3¼c. per lb., basis 60 per cent, for contracts.

Prices on *ammonium carbonate* are somewhat lower at 7@9c. per lb., according to quantity and grade. Prices on *permanganate of potash* are lower from importers at 25@27c. per lb. A slow demand was noted. Prominent *copperas* dealers offer prime green crystals on the basis of $19@$20 per ton in barrels and $17.50 per ton f.o.b. works in bags. Activity has not been along elaborate lines, but the market appeared quite steady at the above-named prices. Spot prices of *oxalic acid* have been lowered in some directions and sales of both foreign and domestic from 17c. down to 16½c. per lb. It was stated that offerings of foreign material were scarce at the close, as the embargo is having a tendency to hold supplies. Producers report sales at 17½c. per lb. and upward, depending upon the brand and quantity. The inquiry for *sulphate of ammonia* has remained dull throughout the week and consumers are apparently satisfied to let the market take care of itself temporarily. Prominent sellers stated that they were asking $2.15 per 100 lb. for goods in bags, but they would probably accept a shade under this price on any kind of a firm offer for a round lot. Occasional *sulphuric acid* sales of the 60 deg. Baumé went through at $11@$13 per ton, according to seller. Rumors were heard that sales have been put through f.o.b. works a shade under the inside price. The 66 deg. *sulphuric acid* is quoted at $18@$20 per ton. Business in *arsenate of lead* is showing the usual midsummer dullness after a period of fair recovery. A satisfactory volume of business was placed with the insecticide trade, but the bulk of demand has been satisfied. Manufacturers offered the paste at 9c. per lb. and the powdered at 15@17c. per lb., according to quantity. *Alcohol* buying is confined to small quantities with consumers still showing hesitation about placing orders for bulk lots. Prices are nominal and in general will be maintained, although some shading is occasionally done on firm business. Ethyl, 188 proof, is quoted at $4.65@$4.75 per gal.; denatured, 180 proof, is 31@32c. per gal.; 188 proof, 35@36c. per gal, and 190 proof, 37c. per gal. Methanol is 78c. per gal. for the 95 per cent and 80@88c. for the 97 per cent.

COAL-TAR PRODUCTS

Business has been very dull for the handlers of coal-tar products during the past week. The topic of principal interest has been the tariff, and few firms concerned have not sent representatives to Washington to give their views of the case. Immediate interest attaches to the efforts to extend the emergency tariff bill until such time as final action on the Fordney bill might be taken. Further efforts are being made to have the Senate include the licensing provision in the present measure. In the meantime, attempts to sell goods in the spot market are sporadic and few buyers are coming into the market without strong inducements. There were some reports of business with export buyers. *Benzene* is still scarce, although the limited scale of consuming operations has prevented any sharp advances. Makers' quotations are unchanged at 27@33c. per gal. Resellers who have supplies are able to demand premiums over these figures. One of the large consumers of *naphthalene* offered a heavy lot of crushed material in the market and found buyers at 6½c. per lb. Refiners' prices are held at former levels, but without any business of consequence. The consuming demand for *phenol* has taken the greater part of all the low-priced material that was recently offered in the market and it is possible that 10c. per lb. is the present low price. It may be possible that on a firm offer bids of 9½c. per lb. would not be refused. Makers' prices on *H acid* continue to rule in the absence of activity. Quotations are given as $1.15@$1.25 per lb., although it is possible that outside holders can offer limited quantities at concessions.

Manufacturers quote technical *sulphanilic acid* at 27@30c. per lb., according to quantity. Interest is scattered with a few small lots moving. Further signs of weakness in *beta naphthol* are evident in the stand of makers. While no definite defections are admitted by producers, a keen rivalry exists, with each cutting prices for new business. The resale market is quoted at 32@35c. per lb., according to quantity. A few sales of comparatively small lots have been put through, but little consuming demand is noted. The resale market in *dimethylaniline* is practically bare of stocks, but some makers have reduced prices to 45c. per lb. in lots of 10 drums or more and are doing some business at this figure. Other makers quote 60@65c. per lb., according to quantity, but admit that they are not pushing sales. Occasional inquiries are coming into the market for limited quantities. The market on *diphenylamine* is firm in makers' hands at 65@70c. per lb., with resale lots cleaned out. Small lots of *paranitraniline* in resellers' hands have moved recently at 75c. per lb., but the quantities offered at this figure are trifling and have not affected the manufacturers' market of 79@82c. per lb. Interest has been slow. Prices on *aniline oil* have been steady at recent levels. Makers will do 20c. per lb. on firm business in returnable drums. Outside lots of more or less inferior quality can be had in reasonable quantity as low as 18c. per lb.

VEGETABLE OILS

A good inquiry was reported for *chinawood oil* for nearby as well as forward delivery, and with cables from primary sources higher, the undertone at the close was quite firm. Scattered sales of less than carlots were reported at 14c. per lb., while prompt shipment oil from points near by sold on the New York equivalent of 12½c. per lb. For September arrival at New York 11¾c. was asked, with August-September shipment from the Orient quoted nominally at 11½c. per lb. c.i.f. New York. Internal difficulties in China may result in a smaller movement of oil to the ports and operators here believe that a shortage in the supply may exist later on. A sale of 500 tons of *Manila coconut oil* for September shipment was reported on the basis of 7¼c. per lb., loose, c.i.f. San Francisco. Further offerings were reported on this basis during the week, although a generally firmer feeling was in evidence in sympathy with the strength in copra. A sale of 15 tanks of domestic Ceylon type oil was put through at 8¾c. per lb., sellers' tanks, f.o.b. Jersey City. Sales of crude *corn oil* went through during the week at 7c. per lb., sellers' tanks, f.o.b. point of production, Middle West. The market closed firm, with asking prices ranging from 7¼@7¾c. per lb., f.o.b. mills. The market for *edible olive oil* was irregular on selling pressure from abroad and nominal prices for high-grade material on spot ranged from $1.80@$2.25 per gal. Denatured oil on spot closed at $1.20 per gal. The recent rise in exchange, coupled with higher cables from Liverpool, caused prices to hold firm despite the inactivity of large operators. *Lagos oil* on spot sold in a small way as high as 7½c. per lb. Lagos for shipment settled at 6¾c. asked c.i.f. N. Y., with niger quoted at 5¾@5⅞c. per lb. Prices on *linseed oil* are quoted lower on a sharp slump in the Argentine seed market. Quotations are based on 73c. per gal. in barrels, carload lots. Buyers are showing little interest except in small lots for prompt and no interest at all in future deliveries. Offerings of crude *peanut oil* were scanty, and the market closed with prices on the domestic products more or less nominal at 7¼@7¾c. per lb., tank cars, f.o.b. mill. Oriental oil for August shipment from the Coast held at 7½c. per lb., tank car basis.

The Chicago Market

CHICAGO, Aug. 12, 1921.

There was no change in the demand for industrial chemicals during the past two weeks. Dealers report a fair volume of small orders and are apparently satisfied with the movement of their stocks. There is no difficulty in procuring supplies of most items and as a rule prices are unchanged. Buyers are showing no tendency to anticipate on their requirements and are buying supplies only for immediate consumption.

The demand for *caustic soda* continues light with no change in price noted. The solid 76 per cent is available

at $4@$4.10 per 100 lb. and the ground at $4.65@$4.75. Supplies are small with little or no pressure to sell. The request for *soda ash* improved somewhat and prices were steady at $2.60 per 100 lb. for barrels. *Sal ammoniac* continued quiet and supplies were available at 7½@7¾c. per lb. for the white granular. There was no improvement in the demand for *carbon tetrachloride* and the price was unchanged at 11c. per lb. *Carbon bisulphide* was quiet and easy at 6¾@7c. per lb. The movement of *formaldehyde* was slow and supplies were plentiful at 13½c. per lb. for barrels. *Glycerine* was quiet with the inquiry light and few sales reported. Material c.p. was offered freely at 14½c. per lb. for single drums. *Iron sulphate* was in fair request and small sales were noted at $1.90 per 100 lb. *Lead acetate* was in poor demand with supplies available at 13c. per lb.

A better inquiry was noted in some quarters for *caustic potash*, one dealer reporting a good volume of small orders at 6½c. per lb. for the 88-92 per cent material. *Bichromate of potash* was available at lower prices and moved better in some directions. The prevailing quotation was 14c. per lb. for spot goods. Supplies of *sodium bichromate* were smaller with the inquiry improved. Several small sales were noted at 9½c. per lb. Small sales of *sodium acetate* were reported at 4½c. per lb. *Bicarbonate of soda* was unchanged as to price and a fair movement was noted at $2.60 per 100 lb. Dry *bisulphite of soda* was offered at 6c. per lb. in single barrel lots. *Hyposulphite of soda* was quiet and unchanged as to price. Pea crystals were available at $4.05 per 100 lb. Supplies of imported *zinc chloride* were offered at 8½c. per lb. in single cask lots.

There were no developments of consequence in the acid market, the prevailing tone being quiet with prices steady. The 28 per cent commercial grade of *acetic acid* is moving in a fair way at $2.50@$2.75 per 100 lb. for barrels. *Glacial acetic* is extremely quiet and supplies are offered at 9¾@11c. per lb. according to the quantity and holder. *Oxalic acid* is in brisk demand and 18c. per lb. appeared to be the inside quotation on spot goods. The heavy acids are in slightly better request and firm as to price. *Sulphuric acid* is quoted at $19@$20 per ton in tank cars f.o.b. works.

VEGETABLE OILS

Trade in *linseed oil* failed to shown any marked improvement, although the inquiry was reported as fair from the smaller consuming trade. Small lots of the boiled are quoted at 77c. in drums with the usual reduction for the raw.

NAVAL STORES

Business in the naval stores market was of a quiet character the last few days. Small sales of *turpentine* were noted, but nothing in a large way. The market on turpen-

The Iron and Steel Market

PITTSBURGH, Aug. 12, 1921.

Demand upon the steel mills continues to increase, although very slowly. At the middle of July, marking the low point in production, steel production was at slightly under 20 per cent of capacity, while the increase, roughly speaking, is at the rate of one or two points a week. Continuance of the present improvement seems well assured, but would mean a rate of no more than 35 or 40 per cent by November. With improvement in general business, freer inception of construction projects and railroad buying there would be additional improvement in steel demand, but it is quite uncertain whether such influences will be marked between now and the end of the year.

From the monthly report of the American Iron and Steel Institute, giving the steel ingot output of thirty large companies, it may be estimated that production in July was at average rates of approximately 18 per cent by the independents, 25 per cent by the Steel Corporation and 21 per cent by the steel industry as a whole, the rate being under 20 per cent at the middle of July, but increased by the present time to well above 20 per cent. The July production was at the rate of about 11,000,000 gross tons of steel ingots a year, actual production having been 40,881,392 tons tine today was 63c. per gal, in drum lots. *Rosins* were quiet and easy, the "G" grade being available at $6.75 per 280 lb. for less than carlots.

in 1920 and 30,284,682 tons in 1912, the best year before the war. The best estimate of actual capacity seems to be 52,500,000 tons.

STEEL CORPORATION'S UNFILLED OBLIGATIONS DECREASE

The Steel Corporation's unfilled obligations decreased by 287,544 tons during July, to 4,830,324 tons at the end of the month. For five successive months these decreases have run just a little bit under the shipments, the differences between estimated shipments and decrease in unfilled tonnage averaging about 100,000 tons a month, or about 7 per cent of capacity. March shipments were at fully 50 per cent of capacity, while July shipments were at only about 25 per cent of capacity. The showing is precisely in line with the character of the corporation's business. In 1920, when the independents had largely advanced prices, the Steel Corporation accepted contracts from its regular customers such as were expected, roughly speaking, to carry the customers to the middle of the year. With the great decrease in activity it requires much longer to work out the contracts. In recent months the corporation has been receiving most of its business in the form of specifications against these contracts, and with declining prices these specifications have been the subject of negotiation. The independents, on the other hand, obtain most of their business in the form of strictly new orders.

The downward sequence in the degree of market activity is approximately as follows: Sheets, bars, tubular goods, wire products, tin plates, plates, structural shapes, rails. Sheet mill operations are above 30 per cent of capacity, while rail production is almost nil.

DEMAND FOR STEEL PRODUCTS INCREASING SLOWLY

Demand for steel products continues to increase slowly, and is expressed almost wholly in small-lot business, largely carloads, for as prompt shipment as can be made, and this means in many cases shipment within two or three days of receipt of the order, a fortnight being an unusually long period. Thus, whether buyers have "confidence" in the future of prices or not, they are taking very little risk. What they have confidence in is their ability to liquidate their purchases promptly and collect the money.

A close analysis of prices for steel products generally indicates that while there was a more or less steady decline for months at present and in the past week or two is that of prices having barely a sagging tendency. There is no thought that prices will advance from the present level, but the lowest point under present cost conditions is not far away. By "cost" is not meant the actual cost at present, with the overhead and other expenses falling upon a very small production, but the cost with a fair operating rate and present wage rates, freight rates and other factors.

PRICES

Regular prices, generally applicable to carload lots, are: Bars, 1.75c.; shapes and plates, 1.85c.; hoops and bands, 2.40c.; blue annealed sheets, 2.40c.; black sheets, 3c.; galvanized sheets, 4c.; plain wire, 2.50c.; wire nails, $2.75. On particularly desirable orders most if not all of these prices are subject to concessions, but the concessions are only $1, $2 or $3 a ton and as to bars, shapes and plates the concessions are hardly any larger than buyers were able to obtain a fortnight ago. Thus it is not entirely certain that the market is even sagging, whereas until quite recently it was very plainly declining. A broadening in the market, with orders offered in larger sizes, may bring about lower prices, but only by small margins. With present wages and freight rates the average price of finished steel products is unlikely to go $5 a ton below prices now quoted as regular, these prices already being subject to some concessions, as indicated.

Pig iron shows a slightly steadier tone, attributed to stocks of bessemer and foundry grades having become relatively small, though there is still plenty basic. The valley market remains quotable at $20 for bessemer, $18 for basic and $19.50 for foundry. A sale of 500 tons of bessemer was made this week at $21.44, delivered Pittsburgh, or 52c. under the equivalent on valley iron, as the valley-Pittsburgh freight is $1.96.

General Chemicals
CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots		Less Carlots	
Acetic anhydride	lb.			$0.40 –	$0.45
Acetone	lb.	$0.12½ –	$0.12½	.13 –	.13½
Acid, acetic, 28 per cent	100 lbs.	2.75 –	3.00	3.25 –	3.50
Acetic, 56 per cent	100 lbs.	5.00 –	5.25	5.50 –	6.00
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	10.00 –	10.25	10.50 –	10.75
Boric, crystals	lb.	.13½ –	.14	.14½ –	.15
Boric, powder	lb.	.15 –	.15½	.16 –	.16½
Citric	lb.			.44½ –	.45
Hydrochloric	100	1.25 –	1.50	1.60 –	1.75
Hydrofluoric, 52 per cent	lb.	.11½ –	.11½	.12 –	.12½
Lactic, 44 per cent tech	lb.	.10 –	.11	.11½ –	.12
Lactic, 22 per cent tech	lb.	.04½ –	.05½	.06 –	.07
Molybdic, C. P.	lb.	4.00 –	4.50	4.50 –	5.00
Muriatic, 20 deg. (see hydrochloric)					
Nitric, 40 deg	lb.	.06½ –	.06½	.07 –	.07½
Nitric, 42 deg	lb.	.07 –	.07½	.07½ –	.07½
Oxalic, crystals	lb.	.16½ –	.17	.17½ –	.18½
Phosphoric, 50 per cent solution	lb.	.13½ –	.14	.14½ –	.18
Picric	lb.	.20 –	.25	.27 –	.35
Pyrogallic, resublimed	lb.	..... –	.....	1.75 –	1.90
Sulphuric, 60 deg., tank cars	ton	..... –	.....	11.00 –	13.00
Sulphuric, 60 deg., drums	ton	..... –	.....	13.00 –	15.00
Sulphuric, 66 deg., tank cars	ton	18.00 –	20.00		
Sulphuric, 66 deg., drums	ton	21.00 –	22.00	22.50 –	23.00
Sulphuric, 66 deg., carboys	ton	..... –	.....	..... –	.....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	21.00 –	22.00	..... –	.....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	23.00 –	23.50	24.00 –	24.50
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 –	32.00	33.00 –	34.00
Tannic, U. S. P.	lb.			.85 –	1.00
Tannic (tech.)	lb.	.45 –	.48	.50 –	.55
Tartaric, crystals	lb.			.27 –	.28
Tungstic, per lb. of WO	lb.	..... –	.....	1.30 –	1.40
Alcohol, Ethyl	gal.	..... –	.....	4.65 –	4.75
Alcohol, Methyl (see methanol)		..... –	.....	..... –	.....
Alcohol, denatured, 188 proof	gal.			.35 –	.36
Alcohol, denatured, 190 proof	gal.			.37 –	.38
Alum, ammonia lump	lb.	.03½ –	.03½	.04 –	.04½
Alum, potash lump	lb.	.03½ –	.04	.04½ –	.04½
Alum, chrome lump	lb.	.10 –	.11	.11½ –	.12½
Aluminum sulphate, commercial	lb.	.02 –	.02½	.02½ –	.02½
Aluminum sulphate, iron free	lb.	.03 –	.03½	.03½ –	.04
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ –	.07½	.08 –	.08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 –	.32	.33 –	.35
Ammonium carbonate, powder	lb.	.07 –	.07½	.08 –	.09
Ammonium chloride, granular (white salammoniac)	lb.	.06½ –	.06½	.07 –	.08
Ammonium chloride, granular (gray salammoniac)	lb.	.06½ –	.06½	.07 –	.07½
Ammonium nitrate	lb.	.07 –	.07½	.07½ –	.08½
Ammonium sulphate	100 lb.	2.20 –	2.25	2.30 –	2.40
Amylacetate	gal.	..... –	.....	3.25 –	3.50
Amylacetate tech	gal.	..... –	.....	2.50 –	3.00
Arsenic oxide, (white arsenic) powdered	lb.	.06½ –	.07	.07½ –	.08
Arsenic, sulphide, powdered (red arsenic)	lb.	.11 –	.11½	.12 –	.13
Barium chloride	ton	52.00 –	54.00	55.00 –	57.00
Barium dioxide (peroxide)	lb.	.20 –	.21	.22 –	.23
Barium nitrate	lb.	.08 –	.08½	.08½ –	.09½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ –	.04½	.04½ –	.05½
Bleaching powder (see calc. hypochlorite)		..... –	.....	..... –	.....
Blue vitriol (see copper sulphate)		..... –	.....	..... –	.....
Borax (see sodium borate)		..... –	.....	..... –	.....
Brimstone (see sulphur, roll)		..... –	.....	..... –	.....
Bromine	lb.	.27 –	.28	.28½ –	.30
Calcium acetate	100 lbs.	2.00 –	2.05	..... –	.....
Calcium carbide	lb.	.04½ –	.04½	.05 –	.05½
Calcium chloride, fused, lump	ton	23.50 –	24.00	24.50 –	25.50
Calcium chloride, granulated	lb.	.01½ –	.02	.02½ –	.02½
Calcium hypochlorite (bleach'g powder)	100 lb.	2.30 –	2.50	2.60 –	3.00
Calcium peroxide	lb.	..... –	.....	1.40 –	1.50
Calcium phosphate, tribasic	lb.	..... –	.....	.15 –	.16
Camphor	lb.	..... –	.....	.72 –	.74
Carbon bisulphide	lb.	.06 –	.06½	.06½ –	.07½
Carbon tetrachloride, drums	lb.	.10½ –	.10½	.11 –	.12
Carbonyl chloride (phosgene)	lb.	..... –	.....	.60 –	.75
Caustic potash (see potassium hydroxide)		..... –	.....	..... –	.....
Caustic soda (see sodium hydroxide)		..... –	.....	..... –	.....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.08 –	.09	.09½ –	.10
Chloroform	lb.	..... –	.....	.38 –	.43
Cobalt oxide	lb.	..... –	.....	2.35 –	2.40
Copperas (see iron sulphate)		..... –	.....	..... –	.....
Copper carbonate, green precipitate	lb.	.19 –	.19½	.20 –	.21
Copper cyanide	lb.	..... –	.....	.50 –	.62
Copper sulphate, crystals	lb.	.05½ –	.05½	.06 –	.06½
Cream of tartar (see potassium bitartrate)		..... –	.....	..... –	.....
Epsom salt (see magnesium sulphate)		..... –	.....	..... –	.....
Ethyl Acetate Com. 85%	gal.	..... –	.....	1.00 –	1.10
Ethyl Acetate pure (acetic ether 98% to 100%)	lb.			.40 –	.42
Formaldehyde, 40 per cent	lb.	.12½ –	.13	.13½ –	.13½
Fusel oil, ref.	gal.	..... –	.....	3.25 –	3.75
Fusel oil, crude	gal.	..... –	.....	1.50 –	1.75
Glauber's salt (see sodium sulphate)		..... –	.....	..... –	.....
Glycerine, C. P. drums extra	lb.	..... –	.....	.14½ –	.15
Iodine, resublimed	lb.	..... –	.....	3.50 –	3.60
Iron oxide, red	lb.	..... –	.....	.10 –	.20
Iron sulphate (copperas)	ton	19.00 –	20.00	21.00 –	22.00
Lead acetate	lb.	..... –	.....	.10½ –	.12½
Lead arsenate, paste	lb.	.09 –	.09½	.10 –	.11
Lead nitrate	lb.	..... –	.....	.15 –	.20
Litharge	lb.	.07½ –	.07½	.08 –	.08½
Lithium carbonate	lb.	..... –	.....	1.30 –	1.40
Magnesium carbonate, technical	lb.	.09 –	.09½	.10 –	.11
Magnesium sulphate, U. S. P.	100 lb.	2.40 –	2.75		
Magnesium sulphate, technical	100 lb.	..... –	.....	1.20 –	1.60
Methanol, 95%	gal.	..... –	.....	.78 –	.79
Methanol, 97%	gal.	..... –	.....	.80 –	.88
Nickel salt, double	lb.	..... –	.....	.12 –	.12½
Nickel salt, single	lb.	..... –	.....	.14 –	.14½
Phosgene (see carbonyl chloride)		..... –	.....	..... –	.....
Phosphorus, red	lb.	.40 –	.41	.42 –	.45
Phosphorus, yellow	lb.	..... –	.....	.30 –	.35
Potassium bichromate	lb.	.11½ –	.11½	.12 –	.12½

		Carlots		Less Carlots	
Potassium bitartrate (cream of tartar)	lb.	$ — $		$0.28½	$0.29½
Potassium bromide, granular	lb.	—		.16	.25
Potassium carbonate, U. S. P.	lb	.35	.40	.45	.50
Potassium carbonate, 80–85%	lb.	.05	.05½	.06	.06½
Potassium chlorate, crystals	lb.	.08	.08½	.09	.12
Potassium cyanide	lb	—		.26	.28
Potassium hydroxide (caustic potash)	lb.	.04½	.05	.05½	.06
Potassium muriate, 80% K.C.L.	ton	42.50	45.00		
Potassium iodide	lb.	—		2.75	3.00
Potassium nitrate	lb.	.09½	.09½	.10	.12½
Potassium permanganate	lb.	.25	.26	.26½	.27
Potassium prussiate, red	lb.	.28	.29	.29½	.30
Potassium prussiate, yellow	lb.	.21	.22	.22½	.23
Potassium sulphate (powdered)	per unit	—		1.35	1.35
Rochelle salts (see sodium potas. tartrate)		—		—	
Salammoniac (see ammonium chloride)				—	
Sal soda (see sodium carbonate)				—	
Salt cake	ton	—		22.00	25.00
Silver cyanide	oz.	—		1.35	1.38
Silver nitrate	oz.	—		.41½	.42
Soda ash, light	100 lb.	2.00	2.10	2.15	2.50
Soda ash, dense	100 lb.	2.35	2.40	2.45	2.70
Sodium acetate	lb.	.04	.04½	.04½	.05
Sodium bicarbonate	100 lb.	2.25	2.40	2.50	2.75
Sodium bichromate	lb.	.08	.08½	.08½	.09
Sodium bisulphate (nitre cake)	ton	5.00	5.25	5.50	6.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½	.05	.05½	.06
Sodium borate (borax)	lb.	.05	.06	.06½	.06½
Sodium carbonate (sal soda)	100 lb.	1.90	2.00	2.10	2.40
Sodium chlorate	lb.	.07½	.07¾	.08	.08½
Sodium cyanide	lb.	.19½	.21	.22	.30
Sodium fluoride	lb.	.11	.11½	.12	.13
Sodium hydroxide (caustic soda)	100 lb.	3.60	3.70	3.80	4.40
Sodium hyposulphite	lb	—		.03½	.03½
Sodium nitrate	100 lb.	2.10		2.30	
Sodium nitrite	lb.	.07	.07½	.07½	.08
Sodium peroxide, powdered	lb.	.25	.26	.27	.30
Sodium phosphate, dibasic	lb.	.04½	.04½	.05	.05½
Sodium potassium tartrate (Rochelle salts)	lb.	—		.22	.25
Sodium prussiate, yellow	lb.	.11½	.12	.12½	.13
Sodium silicate, solution (40 deg.)	100 lb.	1.00	1.15	1.25	1.40
Sodium silicate, solution (60 deg.)	lb.	.02½	.03	.03½	.03½
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.50	1.75	2.00	2.25
Sodium sulphide, fused, 60–62 per cent (conc.)	lb.	.05	.05½	.05½	.06½
Sodium sulphite, crystals	lb.	.03½	.04	.04½	.04½
Strontium nitrate, powdered	lb.	.15	.15½	.16	.17
Sulphur chloride, red	lb.	.07	.07½	.07½	.08
Sulphur, crude	ton	20.00	22.00		
Sulphur dioxide, liquid, cylinders extra	lb.	.08	.08½	.09	.10
Sulphur (sublimed), flour	100 lb.	—		2.25	3.10
Sulphur, roll (brimstone)	100 lb.	—		2.00	2.75
Tin bichloride, 50 per cent	lb.	.18	.19		
Tin oxide	lb.	—		.38	.40
Zinc carbonate, precipitate	lb.	.15½	.16	.16½	.17
Zinc chloride, gran	lb.	.11	.11½	.11½	.12
Zinc cyanide	lb.	.42	.44	.45	.47
Zinc dust	lb.	.11½	.11½	.11½	.12½
Zinc oxide, XX	lb.	.07½	.07½	.08	.09
Zinc sulphate	100 lb.	3.00	3.25	3.30	3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10	—	$1.15	
Alpha-naphthol, refined	lb.	1.25	—	1.30	
Alpha-naphthylamine	lb.	.35	—	.40	
Aniline oil, drums extra	lb.	.18	—	.21	
Aniline salts	lb.	.25	—	.28	
Anthracene, 80% in drums (100 lb.)	lb.	.75	—	1.00	
Benzaldehyde U.S.P.	lb.	1.00	—	1.25	
Benzidine, base	lb.	.85	—	1.00	
Benzidine sulphate	lb	.75	—	.85	
Benzoic acid, U.S.P.	lb.	.60	—	.65	
Benzoate of soda, U.S.P.	lb.	.55	—	.60	
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27	—	.32	
Benzene, 90% in drums (100 gal.)	gal.	.25	—	.28	
Benzyl chloride, 95–97%, refined	lb.	.25	—	.27	
Benzyl chloride, tech	lb.	.20	—	.23	
Beta-naphthol benzoate	lb.	3.50	—	4.00	
Beta-naphthol, sublimed	lb.	.70	—	.75	
Beta-naphthol, tech	lb.	.32	—	.35	
Beta-naphthylamine, sublimed	lb.	1.75	—	1.80	
Cresol, U. S. P., in drums (100 lb.)	lb.	.16	—	.18	
Ortho-cresol, in drums (100 lb.)	lb.	.25	—	.27	
Cresylic acid, 97–99%, straw color, in drums	gal.	.68	—	.75	
Cresylic acid, 75–97%, dark, in drums	gal.	.65	—	.70	
Cresylic acid, 50%, first quality, drums	gal.	.45	—	.50	
Dichlorbenzene	lb.	.06	—	.09	
Diethylaniline	lb.	1.20	—	1.25	
Dimethylaniline	lb.	.45	—	.55	
Dinitrobenzene	lb.	.26	—	.28	
Dinitrochlorbenzene	lb.	.20	—	.30	
Dinitronaphthalene	lb.	.30	—	.40	
Dinitrophenol	lb.	.35	—	.40	
Dinitrotoluene	lb.	.27	—	.30	
Dip oil, 25%, car lots, in drums	gal.	.40	—	.45	
Diphenylamine	lb.	.65	—	.70	
H-acid	lb.	1.15	—	1.25	
Meta-phenylenediamine	lb.	1.15	—	1.20	
Monochlorbenzene	lb.	.12	—	.14	
Monoethylaniline	lb.	1.75	—	1.85	
Naphthalene crushed, in bbls.	lb.	.06½	—	.07½	
Naphthalene, flake	lb.	.06½	—	.08	
Naphthalene, balls	lb.	.08	—	.09½	
Naphthionic acid, crude	lb.	.70	—	.75	
Nitrobenzene	lb.	.12	—	.15	
Nitro-naphthalene	lb.	.30	—	.35	
Nitro-toluene	lb.	.16	—	.18	
Ortho-amidophenol	lb.	3.10	—	3.20	
Ortho-dichlor-benzene	lb.	.15	—	.20	
Ortho-nitro-phenol	lb.	.80	—	.85	
Ortho-nitro-toluene	lb.	.15	—	.20	
Ortho-toluidine	lb.	.20	—	.25	
Para-amidophenol, base	lb.	1.40	—	1.45	
Para-amidophenol, HCl	lb.	1.60	—	1.75	

Para-dichlorbenzene	lb.	.15	—	.20	
Paranitroaniline	lb.	.75	—	.80	
Para-nitrotoluene	lb.	.85	—	.95	
Para-phenylenediamine	lb.	1.70	—	1.95	
Para-toluidine	lb.	1.25	—	1.40	
Phthalic anhydride	lb.	.50	—	.60	
Phenol, U. S. P., drums	lb.	.09½	—	.11	
Pyridine	gal.	2.00	—	3.50	
Resorcinol, technical	lb.	1.60	—	1.65	
Resorcinol, pure	lb.	2.25	—	2.30	
Salicylic acid, tech., in bbls.	lb.	.19	—	.22	
Salicylic acid, U. S. P.	lb.	.20	—	.25	
Salol	lb.	.75	—	.80	
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25	—	.28	
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14	—	.16	
Sulphanilic acid, crude	lb.	.27	—	.30	
Tolidine	lb.	1.25	—	1.35	
Toluidine, mixed	lb.	.40	—	.45	
Toluene, in tank cars	gal.	.25	—	.28	
Toluene, in drums	gal.	.28	—	.31	
Xylidines, drums, 100 gal.	lb.	.40	—	.45	
Xylene, pure, in drums	gal.	.40	—	.45	
Xylene, pure, in tank cars	gal.	.45	—		
Xylene, commercial, in drums, 100 gal.	gal.	.33	—	.35	
Xylene, commercial, in tank cars	gal.	.30	—		

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.24	—	$0.25	
Beeswax, refined, light	lb.	.27	—	.28	
Beeswax, white pure	lb.	.40	—	.45	
Carnauba, Flora	lb.	.58	—	.60	
Carnauba, No. 2, North Country	lb.	.25	—	.26	
Carnauba, No. 3, North Country	lb.	.13½	—	.14	
Japan	lb.	.15½	—	.16½	
Montan, crude	lb.	.06½	—	.06½	
Paraffine waxes, crude match wax (white) 105–110 m.p.	lb.	.03	—	.03½	
Paraffine waxes, crude, scale 124–126 m.p.	lb.	.02½	—		
Paraffine waxes, refined, 118–120 m.p.	lb.	.03	—	.03½	
Paraffine waxes, refined, 125 m.p.	lb.	.03½	—	.03½	
Paraffine waxes, refined, 128–130 m.p.	lb.	.04	—	.04½	
Paraffine waxes, refined, 133–135 m.p.	lb.	.04½	—	.05	
Paraffine waxes, refined, 135–137 m.p.	lb.	.05½	—	.06	
Stearic acid, single pressed	lb.	.09	—		
Stearic acid, double pressed	lb.	.09½	—		
Stearic acid, triple pressed	lb.	.10	—	.10½	

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$4.95	—		
Rosin E-I	280 lb.	5.05	—	5.30	
Rosin K-N	280 lb.	5.40	—	5.85	
Rosin W. G.-W. W	280 lb.	6.60	—	7.35	
Wood rosin, bbl.	280 lb.	6.25	—		
Spirits of turpentine	gal.	.66	—		
Wood turpentine, steam dist	gal.	.64	—		
Wood turpentine, dest. dist.	gal.	.62	—		
Pine tar pitch, bbl.	200 lb.		—	7.00	
Tar, kiln burned, bbl. (500 lb.)	bbl.		—	11.50	
Retort tar, bbl.	500 lb.		—	11.50	
Rosin oil, first run	gal.	.35	—		
Rosin oil, second run	gal.	.37	—		
Rosin oil, third run	gal.	.41	—		
Pine oil, steam dist., sp.gr. 0.930–0.940	gal.			$1.80	
Pine oil, pure, dest. dist.	gal.			1.50	
Pine tar oil, ref., sp.gr. 1.025–1.035	gal.			.46	
Pine tar oil, crude, sp.gr. 1.025–1.035 tank cars f.o.b. Jacksonville, Fla.	gal.			.35	
Pine tar oil, double ref., sp.gr. 0.965–0.990	gal.			.75	
Pine tar, ref., thin, sp.gr. 1.080–1.960	gal.			.35	
Turpentine, crude, sp. gr. 0.900–0.970	gal.			1.20	
Hardwood oil, f.o.b. Mich., sp.gr. 0.960–0.990	gal.			.35	
Pinewood creosote, ref.	gal.			.52	

Solvents

73–76 deg., steel bbls. (85 lb.)	gal.		$0.41
70–72 deg., steel bbls. (85 lb.)	gal.		.39
68–70 deg., steel bbls. (85 lb.)	gal.		.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.		.30

Crude Rubber

Para—Upriver fine	lb.	$0.16	—	.17	
Upriver coarse	lb.	.09	—	.09½	
Upriver caucho ball	lb.	.11½	—	.12	
Plantation—First latex crepe	lb.	.14	—		
Ribbed smoked sheets	lb.	.12	—	.12½	
Brown crepe, thin, clean	lb.	.15	—		
Amber crepe No. 1	lb.	.17	—		

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.09½	—	$0.09½	
Castor oil, AA, in bbls.	lb.	.10½	—	.11	
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.12	—	.12½	
Cocoanut oil, Ceylon grade, in bbls.	lb.	.09½	—	.10	
Cocoanut oil, Cochin grade, in bbls.	lb.	.10½	—	.10½	
Corn oil, crude, in bbls.	lb.	.08½	—	.08½	
Cottonseed oil, crude (f. o. b. mill)	lb.	.07	—	.07½	
Cottonseed oil, summer yellow	lb.	.08½	—	.09	
Cottonseed oil, winter yellow	lb.	.09½	—		
Linseed oil, raw, car lots (domestic)	gal.	.73	—	.74	
Linseed oil, raw, tank cars (domestic)	gal.	.67	—	.68	
Linseed oil, in 5-bbl lots (domestic)	gal.	.75	—	.76	

Olive oil, Denatured	gal.	$1.20	—	$1.25
Palm, Lagos	lb.	.07	—	.07½
Palm, Niger	lb.	.06	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.07½	—	.07½
Peanut oil, refined, in bbls.	lb.	.10½	—	.10½
Rapeseed oil, refined in bbls.	gal.	.95	—	.96
Rapeseed oil, blown, in bbls.	gal.	.98	—	.99
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08	—	....
Soya bean oil, tank cars f.o.b., Pacific coast	lb.	.06½	—	....

FISH

Light pressed menhaden	gal.	$0.42	—	....
Yellow bleached menhaden	gal.	.44	—	....
White bleached menhaden	gal.	.46	—	....
Blown menhaden	gal.	.50	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00	—	26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri	net ton	7.00	—	....
Blanc fixe, dry	lb.	.04½	—	.04½
Blanc fixe, pulp	net ton	45.00	—	55.00
Casein	lb.	.06½	—	.07½
Chalk, domestic, extra light	lb.	.04½	—	.05
Chalk, domestic, light	lb.	.04	—	.04½
Chalk, domestic, heavy	lb.	.03½	—	.04
Chalk, English, extra light	lb.	.04½	—	.05
Chalk, English, light	lb.	.04½	—	.05
Chalk, English, dense	lb.	.04	—	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	15.00	—	25.00
China clay (kaolin) imported, lump	net ton	12.00	—	20.00
China clay (kaolin) imported, powdered	net ton	20.00	—	25.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.	net ton	18.00	—	....
Fullers earth, imported, powdered	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality	lb.	.07	—	.07½
Graphite, Ceylon chip	lb.	.05½	—	.05½
Graphite, high grade amorphous crude	lb.	.02½	—	.03
Magnesite, calcined	per ton	66.00	—	70.00
Pumice stone, imported, lump	lb.	.04	—	.50
Pumice stone, domestic lump	lb.	.05	—	.05½
Pumice stone, ground	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton		—	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton		—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton		—	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	—	7.50
Shellac, orange fine	lb.	.52	—	.53
Shellac, orange superfine	lb.	.55	—	.56
Shellac, A. C. garnet	lb.	.44	—	.45
Shellac, T. N.	lb.	.45	—	.46
Soapstone	ton	12.00	—	15.00
Sodium chloride	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars	ton	10.00	—	14.00
Talc, imported	ton	30.00	—	40.00
Talc, California talcum powder grade	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton	$37.50–40.00		
Carborundum refractory brick, 9-in., less than carlot	1,000	1250.00		
Carborundum refractory brick, 9-in., carload lots	1,000	1100.00		
Chrome brick, f.o.b. Eastern shipping points	net ton	60		..
Chrome cement, 40–45% Cr₂O₃	net ton	30	–	32
Chrome cement, 40–45% Cr₂O₃, sacks, in car lots, f.o.b. Eastern shipping points	net ton	33	–	35
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	36	–	40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	30	–	35
Magnesite brick, 9-in. straight	net ton	70		
Magnesite brick, 9-in. arches, wedges and keys	net ton	77		
Magnesite brick, soaps and splits	net ton	98		
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	42	–	45
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	46	–	50
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	35	–	38

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.14	—	....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.15	—	....
Ferromanganese, 76-80% Mn, domestic	net ton	65.00	—	70.00
Ferromanganese, 76-80% Mn, English	net ton	65.00	—	70.00
Spiegeleisen, 18-22% Mn	net ton	26.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.50	—	....
Ferrosilicon, 10-15%	net ton	40.00	—	42.00
Ferrosilicon, 50%	net ton	65.00	—	68.00
Ferrosilicon, 75%	net ton	135.00	—	138.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.45	—	.50
Ferrouranium, 35-50% of U, per lb. of U content	lb.	6.00	—	....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$8.00	—	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr₂O₃	unit	.30	—	.33
Chrome ore, 50% Cr₂O₃, f.o.b. Atlantic seaboard	unit	.30	—	.33
Coke, foundry, f.o.b. ovens	net ton	4.00	—	4.50
Coke, furnace, f.o.b. ovens	net ton	2.75	—	3.00
Coke, petroleum, refinery, Atlantic seaboard	net ton	14.00	—	15.00
Fluorspar, lump, f.o.b. mines, New Mexico	net ton	12.50	—	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00	—	....
Ilmenite, 52% TiO₂, per lb. ore		.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.22	—	....
Manganese ore, chemical (MnO₂)	net ton	50.00	—	55.00
Molybdenite, 85% MoS₂, per lb. of MoS₂, N. Y.	lb.	.55	—	.60
Monazite, per unit of ThO₂, c.i.f., Atlantic seaport	unit	30.00	—	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.12	—	.12
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11	—	.12
Rutile, 95% TiO₂ per lb. ore	lb.	.15	—	....
Tungsten, scheelite, 60% WO₃ and over, per unit of WO₃ (nominal)	unit	2.75	—	3.00
Tungsten, Wolframite, 60% WO₃ and over, per unit of WO₃, N. Y. C.	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U₃O₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U₃O₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium ore, per lb. of V₂O₃ contained	lb.	1.00	—	....
Zircon, washed, iron free	lb.	.03	—	....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.00
Aluminum, 98 to 99 per cent	24.5@25
Antimony, wholesale lots, Chinese and Japanese	4½
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, spot and blocks	35.00
Monel metal ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	27.00
Lead, New York, spot	4.35–4.45
Lead, E. St. Louis, spot	4.25
Zinc, spot, New York	4.60
Zinc, spot, E. St. Louis	4.25

OTHER METALS

Silver (commercial)	oz.	$0.60½
Cadmium	lb.	1.00–1.25
Bismuth (500 lb. lots)	lb.	1.50@1.55
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	69.00@72.00
Iridium	oz.	160.00@180.00
Palladium	oz.	50.00–53.00
Mercury	75 lb.	43.50–45.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.00@20.25
Copper bottoms	27.50@27.75
Copper rods	19.25@19.75
High brass wire	16.75
High brass rods	13.75
Low brass wire	18.25
Low brass rods	18.25
Brazed brass tubing	27.00
Brazed bronze tubing	31.75
Seamless copper tubing	21.00
Seamless high brass tubing	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible	9.00@9.25	9.25	9.50
Copper, heavy and wire	8.25@8.50	8.50	8.50
Copper, light and bottoms	7.00@7.25	7.50	7.25
Lead, heavy	3.00@3.25	3.25	3.25
Lead, tea	2.25@2.35	2.25	2.25
Brass, heavy	4.00@4.25	4.50	5.00
Brass, light	3.00@3.25	3.25	3.50
No. 1 yellow brass turnings	3.75@4.00	4.25	4.50
Zinc	2.00@2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are f.o.b. structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	$2.23	$3.00	$3.00
Soft steel bars	2.18	2.80	2.80
Soft steel shapes	2.18	2.90	2.90
Soft steel bands	2.50	3.20	3.20
Plates, ¼ to 1 in. thick	2.18	3.00	3.00

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Birmingham Flour Mills have plans under way for the construction of a new flour milling plant on a local site to be about 140 x 150 ft., and estimated to cost close to $150,000.

GADSDEN—The Tri-City Gas Co. has completed plans for extensions in its generating plant to double the present capacity. Extensions will also be made in the distributing system. The work will be inaugurated at once.

California

MELROSE—The National Lead Co. of California has completed plans and will soon commence construction of a new unit at its plant for lead-refining operations. Headquarters of the company are at 485 California St., San Francisco.

TURLOCK—The Turlock Gas Co. will make improvements and additions in its plant on South Front St., to cost about $50,000.

TRACY—Officials of the Chamber of Commerce are holding a series of meetings relative to the establishment of a municipal gas manufacturing plant. O. W. Smith is at the head of the project.

Connecticut

OAKVILLE—The Connecticut Rubber Co., Hartford, has acquired an existing factory building at Oakville, near Waterbury, for the establishment of a new plant for the manufacture of rubber tubes and other rubber specialties. A number of improvements will be made in the structure and equipment installed at an early date. It is expected to give employment to about 100 operatives for initial production. The company is now operating a similar plant at Yale, Okla.

NEW HAVEN—The Seamless Rubber Co., Inc., is adding to its working force for increased production. The company has recently taken on about 150 additional persons.

Florida

TAMPA—The Nu-Tex Brick Co., which has begun the construction of a local plant for the manufacture of brick and other burned clay products, has been incorporated under state laws as the Florida Nu-Tex Brick & Tile Co., with capital of $200,000. It is expected to have the plant ready for operation early in the fall. W. B. Coarsey is president and general manager; and H. E. Lough, secretary and treasurer.

DADE CITY—The Florida Cane Syrup Co. has preliminary plans under way for the establishment of a new local works for the manufacture of cane sirups. The equipment installation, including grinding mill, conveyor apparatus, cooking vats, etc., is estimated to cost in excess of $50,-000. E. S. Slough is general manager.

Indiana

DUNKIRK—The Hart Mfg. Co., specializing in the manufacture of glass jars and containers, is completing the installation of new machinery for jar production. Present operations will be on a curtailed basis with full resumption expected in the near future.

Illinois

CHICAGO—E. F. Houghton & Co., Shields Ave., manufacturer of lubricating oils, etc., has awarded a contract to the Austin Co., 208 South LaSalle St., for the construction of a new 1-story building at 3524 Shields Ave., 37 x 100 ft.

CHICAGO—The Arabol Mfg. Co., 200 North Jefferson St., manufacturer of liquid glue, etc., is planning for the early occupancy of its new 1-story and basement plant on Fifty-fourth St., now nearing completion. It will be 60 x 100 ft., estimated to cost about $25,000.

BLUE ISLAND—The American Wire Fabrics Co., 208 South LaSalle St., Chicago, has awarded a contract to A. and E. Anderson, 19 South LaSalle St., for the construction of its proposed new galvanizing plant at the Blue Island works to be 48 x 145 ft. With a warehouse building to be erected at the same time, the cost is estimated at about $100,000.

Maine

GREENVILLE—The Great Northern Paper Co., Millinocket, Me., has awarded a contract to the H. P. Cummings Construction Co., Fidelity Bldg., Portland, Me., for the erection of its proposed new 1-story shop addition at Greenville, 100 x 218 ft.

Maryland

LUKE—The West Virginia Pulp & Paper Co. has commenced the erection of a new addition at its local mills.

BALTIMORE—The Co-operative Paper Box Co., recently organized, will install machinery in a local building for the manufacture of paper boxes and containers. It is proposed to develop an output of about 10,000 boxes per day. B. F. Garrett, 3502 Cottage Ave., Govans, Md., is president; A. W. Watson, 4916 Alhambra Ave., Baltimore, is manager.

Massachusetts

BOSTON—Tileston & Hollingsworth, 892 River St., Hyde Park, manufacturer of paper products, have awarded a contract to the Aberthaw Construction Co., 27 School St., for the construction of two additions to its plant, to the finishing department and machine building, respectively.

Michigan

KALAMAZOO—The Western Paper Makers' Chemical Co. will rebuild the portion of its plant destroyed by fire, July 21, with loss reported at about $12,000.

PONTIAC—The American Forging & Socket Co., Branch St., has preliminary plans under way for the erection of a new 1-story foundry addition, 40 x 50 ft., estimated to cost about $30,000.

New Jersey

GLOUCESTER CITY—Leroy A. Goodwin, P. A. Stewart and J. L. Blandy, members of the local board of directors of the Chamber of Commerce, are interested in the establishment of a local plant for the manufacture of newsprint paper, utilizing the former buildings of the Argo Mills, manufacturer of textile products. A company capitalized at $1,000,000 is being formed by Frank Hummell, owner of the mill property, and associates. A list of machinery for installation at the plant has been arranged, and it is proposed to have the mill ready for service around the close of the year. The Chamber of Commerce has adopted resolutions approving the plans of the company and urging support.

New York

NEW YORK—The Tidal Osage Oil Co., a subsidiary of the Tidewater Oil Co., 11 Broadway, previously known as the Guffey-Gillespie Oil Co., operating oil refineries, etc., has arranged for a bond issue of $3,500,000, the proceeds to be used for general operations, extensions, improvements, etc.

LONG ISLAND CITY—The Mirrorlike Mfg. Co., 203 Eighth St., manufacturer of polishes, has awarded a contract to Walter J. Bond, 333 Jackson Ave., Astoria, L. I., for the construction of its proposed new plant, 100 x 100 ft., on property recently acquired at Queens Blvd. and Buckley St.

NEW YORK—The United Oil Producers Corp., 347 Madison Ave., affiliated with the Middle States Oil Corp. and the Imperial Oil Corp., address as noted, has sold a bond issue aggregating $4,000,000, to be used in part for extensions, improvements, general operations, etc., in connection with its oil refineries.

North Carolina

ROANOKE RAPIDS—The Armstrong Chalborn Co., manufacturer of pulp and paper products, is reported to be planning for the rebuilding of the portion of its mill recently destroyed by fire, with loss estimated in excess of $100,000.

Ohio

CINCINNATI—The Piqua Straw Board Co., 515-19 Eggleston Ave., recently organized, has acquired the Piqua, O., division of the American Straw Board Co., including the plant at Tippecanoe City, O., and the subsidiary company of Cincinnati, known as the Queen City Paper Co. The new organization plans for extensive operations. C. H. Palmer is president.

Pennsylvania

UNIONTOWN—The du Pont Powder Co. is planning for the rebuilding of the press mill at its Oriental works, near Uniontown, destroyed by fire, caused by an explosion, Aug. 3.

Tennessee

BRISTOL—The Enterprise Foundry & Machine Works has acquired a local building for the establishment of a new plant. The structure will be remodeled and a large department equipped as foundry. The work, including equipment, is estimated to cost about $45,000.

Texas

MEXIA—The Golden Star Refining Co. is reported to be planning for the erection of a new oil refinery on local site. The initial plant will have a daily capacity of about 6,000 bbl.

DALLAS—The City Council is having plans prepared for the installation of a new water-purification plant at the White Rock reservoir, to include chemical lines, chemical feed machines, filter equipment and auxiliary apparatus. A bond issue has been arranged to cover the cost. David Morey, Jr., 517 Prætorian Bldg., is engineer for the project. M. G. James is city secretary.

FORT WORTH—The Panther Machine Co., F. & M. Bank Bldg., has plans under way for the erection of a new local plant with extensive foundry department for the manufacture of brass, bronze, aluminum and other metal castings. The company recently increased its capital from $25,000 to $100,000 for expansion. S. Johnson is president and general manager.

Virginia

BRISTOL—The Enterprise Foundry Co. is planning for the early occupancy of its new local plant, comprising the former rolling mill of the Virginia Iron, Coal & Coke Co. Remodeling work is under way, estimated to cost about $45,000, and the present works will be removed to the new site upon completion. Additional equipment will be installed.

Washington

ANACORTES—J. E. Jensen and associates have leased the local plant of the Washington Glass Mfg. Co., for the establishment of a new works for the manufacture of glass specialties. The plant will be remodeled and improved, and additional equipment installed.

West Virginia

MARTINSBURG—Spangler & Oyler, Gettysburg, Pa., manufacturers of fertilizer products, are planning for the rebuilding of their branch plant at Martinsburg, recently destroyed by fire.

HUNTINGTON—The West Virginia Foundry & Stove Works are completing plans for the erection of a new 1-story foundry at their plant, 50 x 120 ft. It is proposed to provide equipment to double the present casting output at the plant. Frank C. Boggess is manager.

Wisconsin

CASPER—The Midwest Refining Co. is planning for the rebuilding of the portion of its local plant, destroyed by fire, July 17, with loss estimated at about $50,000.

CASPER—The Producers & Refiners Corp., Waterloo, Ia., operating the former plant of the Hawkeye Oil Co., is perfecting plans for the erection of a new oil refinery at Casper, with ultimate capacity of about 10,000 bbl. The first unit, ground for which will be broken at an early date, will have an output of about 3,000 bbl. per day. Continuous stills will be installed and all products taken from the crude oil with the

exception of lubricants and waxes. At a later date it is proposed to extend the works to include a wax manufacturing and lubricating oil plant. The entire project is estimated to cost about $5,000,000, including site, recently secured, on the Yellowstone Highway, about 4 miles from Casper.

British Columbia

NEW WESTMINSTER—The Triangle Chemical Co. is planning for the establishment of a new local plant for the manufacture of muriatic acid, sulphuric acid, superphosphates and kindred products.

Capital Increases, etc.

THE GAYNER GLASS WORKS, Salem, N. J., has filed notice of increase in capital from $150,000 to $500,000.

THE WESTERN PAPER MAKERS' CHEMICAL Co., Kalamazoo, Mich., has increased its capital from $200,000 to $1,000,000.

THE SHAMOKIN POWDER Co., Shamokin, Pa., has filed notice of dissolution under state laws.

THE ILLINOIS TERRA COTTA LUMBER Co., Pullman, Ill., manufacturer of burned clay products, has filed notice of dissolution under state laws.

THE CHEMICAL PRODUCTS Co., Detroit, Mich., has filed notice of dissolution under state laws.

New Companies

THE McKINNEY COTTON OIL Co., McKinney, Tex., has been incorporated with a capital of $100,000, to manufacture oil products. The incorporators are J. S. Heard and F. B. Pope.

THE LEWES FERTILIZER Co., Lewes, Del., has been incorporated with a capital of $1,700,000 to manufacture fertilizers, phosphates, etc. The incorporators are Charles D. Murphy, Harrington, Del., and James M. Tunnell, Lewes, Del.

THE DEALERS CO-OPERATIVE OIL Co., Haddonfield, N. J., has been incorporated with a capital of $125,000 to manufacture oil products. The incorporators are Herman Schreiner, Jr., C. E. Brearley and Edward T. Catlett, Haddonfield.

THE TRINACHIA DRUG & CHEMICAL CORP., with a capital of $25,000 to manufacture chemicals, chemical byproducts and kindred specialties. The incorporators are G. Porrazzo and C. Firestone, 299 Broadway, New York, N. Y., has been incorporated

THE REGAL ASBESTOS MINES, INC., New York, N. Y., has been incorporated with a capital of $100,000 to manufacture asbestos products. The incorporators are E. Hemming, E. A. Barth and A. Pettit. The company is represented by McCole & Reid, 80 Maiden Lane.

THE WARWICK CHEMICAL Co., East Greenwich, R. I., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The incorporators are Harry A. J. Clarke, Samuel A. Olevson and John J. Clarke, West Greenwich, R. I.

THE COLONIAL OIL Co., Room 734, 208 South LaSalle St., Chicago, Ill., has been incorporated with a capital of $50,000, to manufacture oil products. The incorporators are William C. Blean, Raynale A. Whitehead and Furber I. Marshall.

THE KEARNEY FOUNDRY Co., Newark, N. J., has been incorporated with a capital of $25,000, to manufacture iron and other metal castings. The incorporators are Robert Douglas, William Baskerville and Colin D. Matier. The company is represented by Clyde D. Souter, 31 Clinton St., Newark.

THE SILICA GEL CORP., Garrett Bldg., Baltimore, Md., has been incorporated with a capital of 600,000 shares of stock, no par value, to manufacture chemicals and chemical byproducts. The incorporators are Benjamin F. Lovelace, Ernest B. Miller and Walter A. Patrick.

THE ENDICOTT OIL Co., Endicott, N. Y., has been incorporated with a capital of $150,000, to manufacture oil products. The incorporators are A. H. Burmont, R. B. Hoadley and W. J. Doyle, 78 Laurel Ave., Binghamton, N. Y.

THE FLASHTITE Co., 208 South Clark St., Chicago, Ill., has been incorporated with a capital of $10,000, to manufacture waterproofing compounds, insulating materials, etc. The incorporators are Andrew G. Burt, Jr., William F. Waugh, and Philip H. Newman.

THE TEXAS SHOPE BRICK Co., Dallas, Tex., has been incorporated with a capital of $75,000, to manufacture brick, tile and

other burned clay products. The incorporators are E. H. Jones, B. K. Howard and J. G. Strawn.

THE LAKE CHAMPION PULP & PAPER CORP., Plattsburgh, N. Y., has been incorporated with a capital of $200,000, to manufacture pulp and paper products. The principal incorporators is Thomson Douglas, 4 Elk St., Albany, N. Y.

THE PATERSON LEATHER Co., Paterson, N. J., has been incorporated with a capital of $50,000, to manufacture leather products. The incorporators are Edward F. Murphy, Martin J. Fogarty and Jacob Van Hetloo, 32 Main St.

THE E. L. COOK BRICK Co., Bridgewater, Mass., has been incorporated with a capital of $100,000, to manufacture brick and other burned clay products. Ernest L. Cook is president, and G. M. Cook, treasurer, both of Bridgewater.

THE BERING-KRAMMERER OIL Co., Long Beach, Cal., has been incorporated with a capital of $500,000, by R. E. and L. H. Bering and William Krammerer, Long Beach, to manufacture petroleum products. The company is represented by Desmond & Larzelere, attorneys, Long Beach.

THE SPANISH AMERICAN CORK PRODUCTS Co., Westport, Md., has been incorporated with a capital of $500,000, to manufacture cork specialties, insulation products and affiliated materials. The incorporators are Walter V. Harrison, C. J. Denhard and Philip S. Ball, Westport.

THE PADDOCK PAPER Co., Providence, R. I., has been incorporated with a capital of $50,000, to manufacture paper products. The incorporators are Stephen D. and Louis N. Paddock and Edward J. Davis, Cranston, R. I.

THE SAN TONE OIL & REFINING Co., San Antonio, Tex., has been incorporated with a capital of $2,500,000, to manufacture refined oil products. James Kepley is president; and M. A. Arnett, secretary and treasurer, San Antonio.

THE METAL CLEANER Co., Wilmington, N. C., has been incorporated with a capital of $125,000, to manufacture cleaning compounds and other chemical specialties. Edward Sandlin is president and general manager; and F. B. Markey, secretary and treasurer, Wilmington.

THE PAN-AMERICAN PAPER PRODUCTS, Philadelphia, Pa., has been incorporated with a capital of $150,000, to manufacture paper specialties. The incorporators are Wells H. Hall, Ira G. and E. H. Ross, Philadelphia. The company is represented by James A. Coady, 914 West St., Wilmington, Del.

THE ECONOMY OIL Co., Taunton, Mass., has been incorporated with a capital of $25,000, to manufacture oil products. Samuel Cohen is president; and Alexander Glaser, 92 Summer St., treasurer.

THE BRICKSTILE Co., 500 Diversey Ave., Chicago, Ill., has been incorporated with a capital of $25,000, to manufacture wax products, tile and other burned clay specialties, and cement materials. The incorporators are H. B. and H. H. Minnick and Ambrose J. Krier.

THE INTERNATIONAL VARNISH & COLOR WORKS, 495 Cortland St., Belleville, N. J., has filed notice of organization to manufacture paints, varnishes, etc. Joseph Bozzol, 312 North Fifteenth St., East Orange, N. J., heads the company.

THE ACME PAPER Co., INC., Boston, Mass., has been incorporated with a capital of 100 shares of stock, no par value, to manufacture paper products. William P. Yanes, is president; and Jacob A. Promboin, 156 Line St., Cambridge, Mass., treasurer.

THE CHATTANOOGA BRICK Co., Chattanooga, Tenn., has been incorporated with a capital of $50,000, to manufacture brick and other burned clay products. The incorporators are Luze C. Hale, Sr., and Robert E. Winsett, Chattanooga.

THE RIDGEWOOD MFG. Co., Brooklyn, N. Y., has been incorporated with a capital of $20,000, to manufacture chemicals and kindred products. The incorporators are E. Luca, C. Cavallino, and C. A. Winter, 507 Fifth Ave., New York.

THE PHILIPPINE REFINING CORP., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture refined oil products. The incorporators are C. W. Hamilton, O. C. Sanborn and A. C. Patterson. The company is represented by Larkin, Rathbone and Perry, 80 Broadway.

THE TONKIN FLAKE GRAPHITE Co., INC., New York, N. Y., has been incorporated with a capital of $150,000, to manufacture graphite products. J. J. Tonkin, Highbridge, N. J., is the principal incorporator.

THE TAR HEEL OIL Co., Greensboro, N. C., has been incorporated with a capital of

$350,000, to manufacture refined oil products. The incorporators are J. M. Hunt, and W. J. Jones, Greensboro; and W. L. Stamey, High Point, N. C.

THE LIFE SAVER SOAP WORKS OF AMERICA, 10 South LaSalle St., Chicago, Ill., has been chartered under state laws, to manufacture soaps and kindred products. The incorporators are Alexander Gibons, M. Goodrich and Louis Kaplan.

THE ELITE CHEMICAL Co., 40 Frank St., Providence, R. I., has filed notice of organization to manufacture chemicals and chemical byproducts. John F. Aptt and Foster F. Hocking head the company.

THE DEFENDER OIL Co., Huntington, W. Va., has been incorporated with a capital of $200,000, to manufacture oil products. The incorporators are C. C. Curtis and G. L. Bremmer, Huntington.

THE HERCULES CORRUGATED BOX CORP., New York, N. Y., has been incorporated with a capital of $60,000, to manufacture corrugated paper products. The incorporators are J. Breem, B. W. Rod and M. London, 55 Liberty St.

THE BROOKLYN PACKERS BYPRODUCTS CORP., Brooklyn, N. Y., has been incorporated with a capital of $10,000, to manufacture greases, oil compounds, fertilizers, etc. The incorporators are L. Weill, M. Lehman and N. D. Shapiro, 892 Broadway, Brooklyn.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN PEAT SOCIETY will hold its fifteenth annual convention at the Hotel Commodore, New York City, Sept. 7, 8 and 9.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass., Oct. 5 to 7.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall convention with the American Pulp and Paper Mill Superintendents' Association, at Washington, Philadelphia, Spring Grove, York, York Haven, Pa., and Wilmington, Del. Oct. 18 to 20.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Oct. 7—American Chemical Society, regular meeting; Oct. 14—Société de Chimie Industrielle, regular meeting; Oct. 21—Society of Chemical Industry, Grasselli Medal; Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society regular meeting.